Bibliography of Subsidence-Related Literature

by

B. A. Trent, R. A. Bauer, P. B. DuMontelle

Illinois State Geological Survey

Illinois Mine Subsidence Research Program

cooperating agencies

ILLINOIS STATE GEOLOGICAL SURVEY
Illinois Department of Energy and Natural Resources
BUREAU OF MINES
United States Department of the Interior
The Illinois Mine Subsidence Research Program (IMSRP) was established in 1985 to investigate methods and develop guidelines for underground mining operations that aim to maximize coal extraction yet preserve the productivity of prime farmland. The research program was initiated by the Illinois Coal Association and the Illinois Farm Bureau.

The Illinois State Geological Survey, a division of the Illinois Department of Energy and Natural Resources, is directing the IMSRP. Participating research institutions include Southern Illinois University at Carbondale, the University of Illinois at Urbana-Champaign, Northern Illinois University, and the Illinois State Geological Survey. A five-year Memorandum of Agreement, signed by the State of Illinois and the Bureau of Mines, U.S. Department of the Interior, ensures collaboration, cooperation, and financial support through 1991. Major funding is also provided by the Illinois Coal Development Board.

This publication is one in a series printed and distributed by the Illinois State Geological Survey as a service to the IMSRP. In the interest of making this information available to the public as quickly as possible, this bibliography has been reviewed for technical accuracy only.

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Illinois State Geological Survey

The Illinois Mine Subsidence Research Program (IMSRP) compiled this bibliography as an aid to mining company technical personnel, persons involved with agriculture in coal-resource areas in Illinois, and mine subsidence researchers. The references were entered onto a computer database management system at the Illinois State Geological Survey (ISGS). Entries were collected from journals, proceedings, bibliographies, public and private libraries, and other sources.

The 2200 references in this bibliography represent the output of the database as of January 1, 1988. This bibliography is not intended to be complete--it will be continually updated. The references are listed alphabetically by first author and year of publication. Short abstracts or descriptions of the works are included with many of the entries. Key subjects are included for each entry. The subject-author index that accompanies the reference list includes 100 selected key subjects.

This database is designed for computer access using more than one keyword. The keywords selected to produce the subject-author index show the advantage of making on-line searches. For example, more than two pages of authors are listed under the keyword "coal mining." During an on-line search, a second, third, or fourth keyword would be entered to narrow the search and better fit the researcher's interest. We have printed the bibliography so that those without access to computers or the ISGS facilities can use the material, and also so that authors may check their entries for errors and omissions.

Readers are invited to call or write the Earth Hazards and Engineering Geology Section of the ISGS with requests for specific searches. The books and articles listed are not necessarily available in libraries; many items may be out of print. We will be pleased to assist researchers in locating reference material if the material is available. Researchers are invited to submit additions to the bibliography. We prefer to receive copies of articles so that we can more easily select keywords.

The basis for this bibliography is INMAGIC, a database management system developed for library use by Inmagic, Inc., Cambridge, MA. The original 741 references used for this database came from U.S. Bureau of Mines Information Circular 9007, "Subsidence Information for Underground Mines--Literature Assessment and Annotated Bibliography." We have followed the general format of IC 9007 for this bibliography. The IMSRP Technical Committee helped to select entries and keywords.

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BIBLIOGRAPHY


subsurface water, hydrology, anthracite, coal mining, environment


insurance


This paper presents a preliminary subsidence prediction model, with data obtained from an instrumentation program implemented at the York Canyon Mine, near Raton, NM.

vertical displacement, prediction, longwall, modeling


ground control


Suggests guidelines for monitoring subsidence over longwall and room-and-pillar retreat mines, including details on monuments and instrumentation.

monitoring design, monitoring installation, monitoring equipment, longwall, room-and-pillar


utilities


longwall, mine operation, mine safety, coal mining


engineering, backfilling


Describes the use of grout columns for support of sites over abandoned mines; discusses borehole photography.

soil mechanics, foundations, mine design, photography, abandoned mines


backfilling


Two existing prediction methods are evaluated for use over United States coal mines: an influence function and a profile function. These methods were applied to several field-measured subsidence profiles.

vertical displacement, prediction, prediction theories, profile function, coal mining

Details the characteristics of surface deformations, including subsidence, inclination, curvature, and horizontal strain; uses data obtained over three longwall panels. Applies two European prediction theories to Appalachian geologic conditions.

prediction theories, vertical displacement, horizontal displacement, coal mining, longwall, prediction, ground control


Specific lithological conditions over the Pittsburgh Coalbed prevent the use of European predictive methods. This paper describes the development of a prediction methodology suitable to mining/geological conditions in the northern Appalachian coal region.

prediction theories, geologic features, angle of draw, longwall, coal mining


The important phases of ground control have been divided into three basic elements: roof, pillar, and floor. For each element, the significant literature dealing with the application of its respective concepts and with the available field evidence has been studied.

ground control, literature search, longwall, roof support, pillar strength, floor stability, ground control, bumps, roof stability


modeling


roof stability


pillar strength, mine design, room-and-pillar, coal mining


prediction


hydrology, coal mining


longwall, floor stability


coil mining, floor stability


rock mechanics, ground control, coal mining


rock mechanics, in situ testing


floor stability, coal mining
  
  roof stability, geotechnical, mine design

  
  roof stability, finite element method, ground control, rock mechanics

  
  mine design, ground control, coal mining

AIME. Report of Sub-Committee on Coal Mining to Committee on Ground Movement and Subsidence. Trans., AIME, v. 74, 1926, pp. 734-809.

At the time (1926), this report was considered to be the most complete collection of subsidence data. In addition to cases already in the literature, questionnaires were sent out to all the large operating bituminous coal companies and to many engineers. The effects of subsidence were discussed under the four main categories of squeezes, multiple-seam extraction, room-and-pillar mining, and longwall mining. Contains a bibliography of subsidence literature from 1913-1924.

- pillar extraction, multiple-seam extraction, mine operation, historical, room-and-pillar, longwall, literature search, coal mining

  
  Presents basics of mine design and operation, including mining methods and roof support.

- roof support, mine design, mine operation, coal mining

  
  coal mining


- monitoring design, monitoring equipment, monitoring installation, seismic

  
  oil extraction


- Discusses the effects of subsidence from underground mining on the surface and intermediate strata. Suggests and recommends mining methods which provide for maximum economical coal extraction along with minimum subsidence.

- mine design, overburden, partial extraction, room-and-pillar, longwall

  
  ground control, coal mining


- land-use planning, mitigation


- survey data processing, ground control, engineering, coal mining

  
  fluid extraction


hydrology, subsurface water, surface water


fluid extraction, monitoring methods, oil extraction


equipment, mine design, land-use planning


describes subsidence monitoring equipment and procedures used at five coal mines in Colorado and Utah.

monitoring installation, monitoring equipment, monitoring design, survey methods, survey equipment, survey data processing, coal mining


The geology, mine plan, and survey network are outlined for three study sites as part of an ongoing subsidence prediction research program conducted in central Utah. Measured values from study sites are compared with two prediction methods: the NCB method, and the Donets profile function.

prediction, prediction theories, vertical displacement, mining design, monitoring equipment, survey methods, longwall, National Coal Board, profile function


Preliminary site information, subsidence results, and a report of the instrumentation are given for a study performed over four adjacent longwall panels in central Utah.

monitoring design, monitoring installation, monitoring equipment, survey methods, longwall, economics, survey equipment, survey data processing


geologic features, coal mining


roof support, ground control


mine operation, coal mining, historical


research methods


This paper describes the investigation of backfilling methods which used mine waste in Pennsylvania.

backfilling, mine waste, coal mining


time design, ground control, longwall, shortwall, roof stability, roof support


rock mechanics, modeling, prediction, overburden, room-and-pillar, longwall, finite element method, roof support, ground control, mine design, boundary element method, continuum mechanics theories, computer, pillar strength, seismic, instrumentation


coal mining, modeling


The applicability to the Sydney Coalfield of existing guidelines for the safe working of undersea coal reserves was uncertain. Land truthed data was extrapolated to undersea conditions, rather than empirically derived from seabed truthed data. Therefore, initiation of a major research effort was proposed to monitor subsidence development over these undersea workings.

surface water, subsurface water, coal mining, multiple-seam extraction, longwall, monitoring design, modeling, instrumentation, prediction, subsidence research


subsurface water, hydrology, longwall, coal mining


engineering, tunnelling


surface structural damage, tunnelling


surface structural damage, tunnelling


tunnelling


A cement company in Illinois successfully stopped a coal company from mining underneath its property. The cement company was mining limestone and shale about 125 ft. under the surface, by the room-and-pillar method. The coal company was mining by longwall advance methods in a seam about 450 ft. below the limestone bed. Survey data were collected for over three years and used as evidence in the suit.

longwall, law, non-metal mining, room-and-pillar, multiple-seam extraction, utilities, coal mining


floor stability


time factor, ground control, coal mining


detailing research on fill properties and filling techniques.
backfilling


discusses effects of different backfilling systems on surface subsidence and resulted surface damage in shallow workings; compares subsidence recorded where both a full and partial area of influence have been worked. Also compares rapidly advancing faces versus conventional machine mine workings.

Ayala, C. F. J., H. R. Lain, H. L. Lain, V. E. Perianes. Subsidence Control (Determination of Movements at the Surface; Consequences of the Subsidence at the Surface.) Ch. 3.7 in Introduccion a los Usos Industriales y Urbanos del Espacio Subterraneo y Su Tecnologia (Introduction to the Industrial and Urban Uses of the Underground Space, and Their Technology.), pp. 191-194. Instituto Geologico y Minero de Espana, Madrid, Spain, 1986, 351 pp. (English version).

ground control, surface subsidence damage


land-use planning, historical, tunnelling, non-metal mining, abandoned mines, utilities, railways, roads, architecture, subsurface water, modeling, roof stability, pillar strength, elastic theory, roof bolting, rock mechanics


discusses effects of different backfilling systems on surface subsidence and resulted surface damage in shallow workings; compares subsidence recorded where both a full and partial area of influence have been worked. Also compares rapidly advancing faces versus conventional machine mine workings.
backfilling, mine design


backfilling

surface water, subsurface water, hydrology, mine operation


land-use planning


in almost all the cases where minerals are mined, a dual relationship, in legal terms, is to be found. Firstly there is a relationship between the owner of the land and the holder of the mineral rights, regulated mainly by principles of private law. Secondly the State exercises control over the mining of minerals to a greater or lesser extent, depending on the nature of the minerals, and its relationship with the mineral right holder is regulated by public law.
surface structural damage, law, government, historical, non-metal mining, engineering


subsurface water, non-metal mining


design, construction, engineering, law

A series of seven tests were conducted on circular cross-section modelled tunnels simulated in large blocks of jointed tuff-rock simulant. Tests were performed under quasi-static and dynamic loading conditions.

tunneling, modeling


Describes Radmark pneumatic conveyors for backfilling metal mines.

backfilling, metal mining


prediction


coal mining, National Coal Board


surface subsidence damage


ground control, room-and-pillar


backfilling


hydrology, coal mining


prediction, stochastic model


The term "resultant load vector" is defined as the representation of the forces applied to a longwall roof support element by strata activity through a single, quantifiable measure of support resistance.

roof support, roof stability


Describes the use of flocculants to disperse slime throughout the fill material to prevent the formation of impervious slime layers on the top of each fill sequence.

backfilling


backfilling


This paper gives the results of research done near Washington, PA, which involved the instrumentation and monitoring of water table fluctuations and differential strata movements over a longwall mine.

subsurface water, monitoring design, monitoring installation, monitoring equipment, coal mining, longwall


The Wyoming Abandoned Mined Lands program is structured such that the investigation, design, and construction management is done by consulting engineers. During the administration of these projects, it became apparent that not only is the design of vital importance, but also many "non-engineering" items play a key role in the projects' overall well-being.

abandoned mines, reclamation, backfilling, engineering, historical, land-use planning, land values, coal mining, subsidence research


Discusses land-use planning and development in the Colorado Springs area related to mine subsidence and the city's Planning Department Geology Section report, "Guide for Future Land Use." abandoned mines, land-use planning, surface structural damage, soils, reclamation, land values, utilities, coal mining


Deals with the estimation of surface strains and deflections caused as a result of longwall methods. The Sims-Bridge method of prediction is discussed, and displacement-calculation procedures are detailed.

horizontal displacement, prediction, computer


Properties of roof materials from longwall mines in Wales were studied in the laboratory. backfilling, roof stability, longwall, lab testing


Convergence of the roof supported by cogs was measured by automatic recorders. monitoring equipment, roof support


Longwall


Resistance of various types and designs of supports was measured in a longwall mine. roof support, longwall


Compression tests were made to study the strength and manner of failure of packs built with dirt-filled bags for roof support.

roof support, lab testing


mine design


mine design, ground control, longwall, roof stability, roof support


Discusses development and field testing of a method for estimation of the bearing capacity of mine roofs and floors. The relationship between penetration of the strata and imposed loads is determined by in situ tests to define bearing plate dimensions for hydraulic roof support jacks at longwall extraction faces.

pillar strength, roof stability, floor stability, longwall, in situ testing, roof support, coal mining


longwall, ground control, mine design, coal mining

tunnelling, engineering, rock mechanics, mine design, roof stability


longwall


Reviews theories of ground movement due to mining, including opposing opinions concerning the extent and mechanics of surface subsidence.

prediction, surface subsidence damage


Describes the development of empirical equations for the prediction of percolation rate, coefficient of permeability, and seepage velocity for classified hydraulic backfills.

backfilling


Current ground control research at the U.S. Bureau of Mines indicates the need for a simple and inexpensive instrument for measuring mining-induced pressure changes in coal pillars and mine roofs. The Borehole Plated Flatjack (BPF) is an adaptation of existing such instrumentation.

instrumentation, measuring equipment, pillar strength, roof stability, ground control, coal mining


time factor, coal mining


subsurface damage, coal mining


overburden, subsurface subsidence damage, coal mining


Investigates possible fracturing of bedrock within subsided areas over abandoned mines through exploration drilling and closed circuit television.

subsidied areas, abandoned mines, coal mining, longwall, room-and-pillar, geologic features


rock mechanics, coal mining, lab testing


Time Domain Reflectometry (TDR) is an electrical pulse testing technique originally developed to locate breaks in power transmission lines. In the past decade, this technique has been adapted to monitor the movement of rock masses during mining.

monitoring design, monitoring equipment, monitoring installation, monitoring methods, high-extraction retreat, coal mining


hydrology, geologic features


roof support, ground control, pillar strength

prediction, seismic


longwall, mine design, roof stability, roof support


Provides an historical overview of the development of subsidence law in Illinois; reviews the principles of liability and legal problems established by cases.

law, coal mining


A considerable number of important developments in the Illinois coal mine subsidence law have taken place since 1980.

law, government, economics, coal mining, longwall, insurance


subsurface water, anthracite, coal mining


subsurface water, anthracite, coal mining


Describes precise subsidence surveying techniques used in the Yorkshire Coalfield in England. Discusses the variations in subsidence development that occur when packing is increased or partial extraction by strip working is used.

mine design, survey methods, partial extraction, backfilling, survey methods, subsidence research


Presents detailed design drawings of a flexible single floor residential superstructure proposed for both longwall and room-and-pillar mining conditions. All efforts were made to provide an immediately available economical alternative for future home builders on subsidence prone land.

surface structural damage, architecture, construction, foundations, economics


overburden, coal mining, geologic features


non-metal mining


Coal mining has gone on in many parts of Western Europe and North America frequently for 200 years or more. Consequently in many urban areas there are abandoned workings at shallow depth
Methods
I. SCRUBS.

R. E., Assessment Effect Sanford, which and foundations, the Belous, Bell, Bell, Dornisthrope Bennett, Benedict, Benson, Benson. formations. Subsidence, 1977, pp. 562-570. mine design, surface structural damage


Benson, J. B., H. E. Sanford, R. W. Stahl. Conditions and Practices of Coal Mines in the Ruhr District of Western Germany. U.S. Bureau of Mines IC 7549, 1950, 48 pp. Following World War II, a one-year investigation was made of safety conditions and operating practices in German mines. backfilling, mine safety, coal mining


Berbower, R. F. Subsidence Problem in the Long Beach Harbor District. ASCE J. Water and Harbors Div., v. 85, No. WW2, June, 1959, pp. 43-80. Discusses subsidence of the ground surface due to oil extraction and salt water injection to repressure depleted formations. surface water, oil extraction, fluid extraction

which often are unrecorded. Investigation of abandoned coal mine workings is no easy task and requires some knowledge of past methods of mineral exploitation.
coal mining, abandoned mines, geophysical methods


fluid extraction


coal mining, modeling, National Coal Board


elastic theory, modeling


elastic theory, modeling


modeling, elastic theory


Proposes an elastic model theory to describe subsidence resulting from longwall mining with complete or nearly complete caving.

rock mechanics, longwall, elastic theory, modeling


continuum mechanics theories, modeling, elastic theory


stochastic model, modeling


continuum mechanics theories, rock mechanics, modeling


prediction, longwall, modeling, rock mechanics


modeling

Beyer, F. On Predicting Ground Deformations Due to Mining Flat Seams. Thesis presented to the Technical University of Berlin, 1945 (in German).

surface subsidence damage, prediction


pipelines, utilities


economics, coal mining


Available literature was surveyed to establish relationships of various levels of structure damage with various components of ground movements for different categories of buildings.

surface structural damage, engineering, rock mechanics, literature search

Presents a methodology to screen potential sites in the anthracite coalfields to determine which sites would be most appropriate to monitor for impending subsidence activity. Provides an integrated monitoring plan for subsidence detection using surface geophysical techniques. Abandoned mines, anthracite, coal mining, backfilling, mitigation, monitoring design, monitoring equipment, instrumentation, geophysical methods, room-and-pillar


Bieniawski, Z. T. Note on In Situ Testing of the Strength of Coal Pillars. Journal of the South African Institute of Mining and Metallurgy, v. 68, May, 1968, pp. 454-464. The uniform load method and the uniform deformation method are discussed and compared as two possible methods of in situ testing of large coal specimens. A pillar strength formula is proposed for use in South Africa. Also deals with load deformation characteristics of coal pillar strength, in situ testing, coal mining


Bieniawski, Z. T. An Overview of Ground Support Considerations in Room and Pillar Coal Mining. Proc., Polish-American Conf. on Ground Control in Room and Pillar Mining, Southern Illinois University at Carbondale, Carbondale, IL, Aug. 6-8, 1980. coal mining, room-and-pillar, ground control


longwall, roof support


roof support


This paper analyzes the Pennsylvania Bituminous Mine Subsidence Act of 1966—the only comprehensive subsidence act passed by any State. The applicability of this law to other states is discussed.

ground control, law


floor stability, geotechnical, lab testing


longwall, coal mining


pillar extraction, monitoring methods


Environmental concerns have spurred attempts to revegetate areas disturbed by mining. The problems of successfully revegetating such areas are often difficult, even under favorable conditions; under the severe conditions prevailing in the arid and semiarid regions of Australia such difficulties may be extreme.

environment, land-use planning, mine waste


rock mechanics, lab testing


rock mechanics, lab testing


finite element method, modeling


seismic, monitoring design, monitoring equipment, monitoring installation, ground control, bumps, coal mining


Describes automation of deep mines in the future, considering both technological advances and concern for mine safety.

mine safety, mine design, law, coal mining

Blevins, C. T. Coping With High Lateral Stresses in an Underground Coal Mine. Pres. at SME-AIME annual meeting, Dallas, TX, Feb. 14, 1982, Society of Mining Engineers preprint #82-156.

crosscut, coal mining


ground control, coal mining

15


This report contains detailed information on the mining of safety pillars.

vertical displacement, horizontal displacement, mine design, prediction, pillar extraction, surface structural damage, coal mining


Bonello, A. Mining Subsidence and Geology. Ind. Miner., St. Etienne, France, v. 61, No. 10, 1979, pp. 531-541.

geologic features


subsurface water, hydrology, longwall, coal mining


subsurface water, hydrology, coal mining


pillar strength, rock mechanics, coal mining


hydrology, subsurface water, surface water


Describes conditions of cover and strata in the Pittsburgh seam where a body of impounded water was safely undermined.

longwall, surface water, coal mining


engineering, surface structural damage


surface structural damage, land-use planning, mine operation


Discusses historical and current (1961) investigations of subsidence in Michigan iron mines, with details on monitoring methods and techniques. Microseismic observations were used for pillar and drill hole studies.

rock mechanics, seismic, metal mining, pillar strength, monitoring methods, monitoring equipment


The dewatering of hydrological compartments by deep gold mines has resulted in dolomitic sinkholes and subsidence. Great difficulty has been experienced in locating areas of high risk, but certain empirical criteria have been developed.

subsurface water, prediction, metal mining, surface structural damage

pillar strength

Brady, S. D. Subsidence in the Sewickley Bed of Bituminous Coal Caused by Removing the Pittsburgh Bed in Monongalia County, West Virginia. Trans., AIME, Coal Division, Fairmont Meeting, March 26-27, 1931.

The two coal seams had less than 100 ft. of rock between them and were quite frequently owned and mined by different companies. The author concludes that coordination of mine designs and pillar pulling can protect overlying and underlying seams. The upper seam must be developed simultaneously with the lower, but retreat pillar ing of the lower should be after pillar ing of the upper seam.

mine design, pillar extraction, multiple-seam extraction, room-and-pillar, pillar strength, coal mining


surface structural damage


Overview a subsidence investigation program that includes core borings, borehole television, rock mechanics, etc. Also describes instrumentation and stabilization of structures.

surface structural damage, rock mechanics, foundations, architecture, instrumentation


Reviews subsidence prediction methods, (emphasis on European methods); these are divided into two groups, based on mathematical expressions either for the trough profile or for the influence of infinitesimal extraction elements.

vertical displacement, horizontal displacement, prediction, prediction theories


Details two fundamental methods of predicting mine subsidence: the trough profile and the influence of infinitesimal extraction elements. Also included are analyses of horizontal displacements and deformations, surface displacements over inclined seams, time effects, and physical and abstract models.

vertical displacement, horizontal displacement, prediction, prediction theories, surface structural damage, ground control, profile function, influence function, horizontal displacement, time factor


Discusses the practical implications of ground movements involving surface structures and shafts, including structural and underground precautions against mining damage.

surface structural damage, mine design, backfilling, room-and-pillar, vertical displacement, horizontal displacement, time factor, ground control, descriptive theories, surface subsidence damage, surface water


monitoring design, coal mining


A comprehensive reference on protecting existing surface structures from severe subsidence damage. Includes history and appraisal of early prediction methods and a description of the prediction methods currently used in England.

vertical displacement, horizontal displacement, surface structural damage, subsurface structural damage, mine design, surface subsidence control, monitoring design, monitoring installation, monitoring equipment, survey methods, survey equipment, foundations, prediction, historical, geologic features
mine design, coal mining


roof support, longwall, anthracite, coal mining, yielding supports


geologic features

surface structural damage, law, historical, backfilling, partial extraction

overburden, time factor, rock mechanics

geotechnical, surface structural damage

ground control

surface subsurface water, tunnelling, roof support

surface subsidence damage, coal mining

Brown, E. O. F. Packing Excavations in Coal Seams by Means of Water. Trans., Institution of Mining Engineers, v. 28, 1905. This article discusses hydraulic sand backfilling in Poland.
backfilling, mine fires, coal mining

rock mechanics, in situ testing

rock mechanics, in situ testing, lab testing

floor stability, lab testing

Brown, R. E. A Multi-Layered Finite Element Model for Predicting Mine Subsidence. Ph.D. Thesis, Carnegie-Mellon University, Pittsburgh, PA, 1968. Results of a finite element model of subsidence movements were compared to British field data, and showed good agreement for the cases studied.
modeling, prediction, finite element method

economics, room-and-pillar, prediction, abandoned mines, coal mining


surface structural damage, active mines, coal mining

Bruhn, R. W. Case Report: Coal Mine Subsidence in Farmington, West Virginia. Underground Space, v. 9, No. 5-6, 1985, p. 261. The town of Farmington, in Marion County, West Virginia, was visited by consulting geotechnical engineers to determine the cause of ground movements that had become prominent the preceding year.

utilities, surface structural damage, geotechnical, abandoned mines, room-and-pillar, pillar strength, reclamation, backfilling, coal mining

Bruhn, R. W. Influence of Deep Mining on the Ground Water Regime at a Mine in Northern Appalachia. Proc., 2nd Workshop on Surface Subsidence due to Underground Mining, Morgantown, WV, June 9-11, 1986, S. S. Peng, ed. WVU Dept. of Mining Engineering, Morgantown WV, Aug., 1986, pp. 234-248. Findings concerning ground water effects presented in this paper indicate that total extraction mining produced significant water level declines in deep-lying strata, but had little effect on water levels at shallower depths. Post-mining values of hydraulic conductivity were typically somewhat higher than pre-mining values. Changes in water chemistry associated with mining were not sufficient to render the water unfit for human consumption.

subsurface water, hydrology, instrumentation, coal mining


rock mechanics, mine design, metal mining, modeling, elastic theory, boundary element method


Bryan, A., J. G. Bryan, J. Fouche. Some Problems of Strata Control in Pillar Workings. Min. Engineering, v. 123, No. 41, Feb., 1964, pp. 238-266. Discusses possible causes for a mine collapse in South Africa in which 437 people were killed; the collapse covered at least 75 acres. Topics covered include geologic conditions, failure mechanisms, and coal pillar strength.

room-and-pillar, ground control, mine safety, pillar strength


backfilling, multiple-seam extraction, coal mining, historical


Bucky, P. B. Use of Models for the Study of Mining Problems. AIME Technical Publication No. 425, 1931, pp. 3-28. This paper is a discussion and comparison of modeling methods. prediction, modeling, mathematical modeling

Bucky, P. B., A. L. Fortress. Applications of Principles of Similitude to Design of Mine Workings. Trans., Am. Inst. of Mining and Metallurgical Engrs., v. 109, 1934, pp. 25-50. Samples from natural mine arches were tested for strength according to their size and shape.

mine design, roof stability, rock mechanics, lab testing

Formulas based on laws of mechanics are derived for calculating the safe span allowable between pillar center lines, pillar size, and percent extraction.

mine design, pillar strength, roof stability


Barodynamics deals with the behavior of weighty structures and applies laws of mechanics to determine the behavior of the structure and/or the application of similitude to the behavior of small-scale models to determine how the prototype will behave.

roof support, modeling


mine operation


mine operation

Bucky, P. B. Block Caving at Climax. Explosives Engineer, v. 22, 1944, pp. 76-79.

mine operation

Bucky, P. B. Block Caving at Inspiration. Explosives Engineer, v. 22, 1944, pp. 116-119.

mine operation


mine operation


mine operation


mine operation

Bucky, P. B. Block Caving at the Ray Mines. Explosives Engineer, v. 23, 1945, pp. 64-75.

mine operation


rock mechanics


surface structural damage, roads


fluid extraction


fluid extraction, historical


fluid extraction, subsurface water


fluid extraction


fluid extraction, subsurface water, surface subsidence damage

Fluid extraction, hydrology


Describes the use of convergence meters to predict roof falls.

metal mining, roof stability, monitoring equipment


rock mechanics


monitoring methods, survey methods, coal mining


Requirements of environmental legislation enacted in Canada and the United States have made mining operations increasingly complex. This paper briefly reviews the extent of mining activity in both countries and lists its major environmental impacts. Legislation of concern to mine operation is reviewed.

environment, law, mine operation


Discusses mining-extraction methods used to control subsidence effects on the Rhine River in the Federal Republic of Germany; valuable coal deposits under the River had not been mined previously because of possible damage to shipping channels.

surface structural damage, surface water, mine design, economics, hydrology, subsurface water, coal mining


Discusses factors affecting subsidence resulting from longwall mining, including angle of draw, geology, width of extraction, and rate of advance; also contains information on subsidence-control techniques.

mine design, backfilling, law, longwall, partial extraction, coal mining, angle of draw, geologic features


col mining, room-and-pillar, anthracite


Water-saturated alluvial deposits were a constant danger to shallow mines in the northern anthracite field of Pennsylvania. From the strength of rocks, the author offers a formula for the recommended minimum thickness of rock over chambers 24 ft. wide.

roof stability, mine operation, overburden, mine safety, historical


Describes the Automated Resistivity method and discusses sites in Colorado, Wyoming, and Illinois where the Bureau of Mines has used this method to locate abandoned mines and potential subsidence areas.

abandoned mines, computer, surface structural damage, surface subsidence damage


Problems presented by old mine workings affect both present-day mining and land development. This report describes six mining areas in the United States which were investigated with the Bureau's automated resistivity method; results showed a high rate of success in detecting old mines. Field measurement techniques and data analysis procedures are described.

abandoned mines, coal mining, land-use planning, land values, monitoring methods, survey methods, survey data processing


engineering, construction, surface structural damage
foundations, engineering, construction, surface structural damage

foundations

subsurface water, fluid extraction

prediction

geophysical methods

prediction

Burton, D. The Introduction of Mathematical Models for the Purpose of Predicting Surface Movements Due to Mining. Proc., 2nd Conf. on Large Ground Movements and Structures at University of Wales Institute of Science and Technology. Pentech Press, London, April, 1980, pp. 50-64.
mathematical modeling, prediction, modeling

modeling

surface subsidence damage

surface subsidence damage

Photographs Pertain to borehole photography of cavities in dolomitic areas of South Africa.
photography

tunnelling

foundations

backfilling

backfilling

Developments over areas undermined at shallow depths are severely restricted because of the potential for subsidence or sudden collapse of the ground surface. To facilitate planning, it is advantageous to have some idea of the location of the undermined areas as well as a general understanding of the actual conditions underground.

abandoned mines, coal mining, metal mining, land-use planning, photography, historical, surface subsidence damage


abandoned mines


Subsurface reinforcement of bridge footings was achieved by constructing concrete columns within abandoned mines.

abandoned mines, backfilling, multiple-seam extraction, railways


abandoned mines, surface subsidence control


backfilling, rock mechanics


Reports the findings and conclusions of a demonstration project carried out by the city of Rock Springs, WY, in 1970 using the Dowell Process.

abandoned mines, surface subsidence control


abandoned mines, surface subsidence control


horizontal displacement


backfilling


surface subsidence damage, surface water, fluid extraction


abandoned mines, coal mining


Presents test results from investigation of effects of various backfilling parameters (including slurry concentration, injection velocity, and floor slope) on deposition patterns. backfilling


Presents test results from investigation of effects of various backfilling parameters on deposition patterns for five specific mine patterns.

backfilling, modeling


mine design, roof stability, longwall, coal mining

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Foundation failures in underground coal mines frequently occur in mines where the strata under the coal includes underclays or clay shales with poor strength characteristics. An investigation carried out at the University of Missouri-Rolla evaluated the strength and stability parameters of strata underlying coal in the Illinois Basin.

cold mining, floor stability, geotechnical, pillar strength, rock mechanics, finite element method, modeling, computer, roof stability


door stability, coal mining


mine design, ground control, longwall, roof stability


surface structural damage


subsurface water, hydrology, coal mining


surface water, subsurface water, hydrology, coal mining


mine design, ground control, roof support


oil production


fluid extraction, oil extraction, prediction


metal mining, ground control


mine design, ground control, roof stability, coal mining


mine design, ground control, coal mining


surface structural damage


roof support, ground control


A coal pillar on weak floor strata may be considered as a shallow foundation on cohesive soil or rock. The theory of bearing capacity and settlement of shallow foundations may therefore be applied for designing isolated pillars. However, design of multiple coal pillars and evaluation of mine stability requires an additional consideration of interaction among the roof, coal pillar and floor elements.


prediction, non-metal mining


metal mining, surface subsidence damage


To allow pillar removal, concrete columns are constructed for roof support. The columns are poured through 6-inch boreholes from the surface and timber supports are later added between columns.

pillar extraction, roof support


backfilling, coal mining


Hydraulic flushing projects in Scranton, PA used mine waste as the filling material.

surface subsidence control, surface structural damage, economics, backfilling, mine waste, anthracite, coal mining


floor stability


Discusses investigations performed by the USBM to improve development in mining of multiple coalbeds. Two common interactions that occur between adjacent coalbeds are subsidence and pillar load transfer. Underground measurements obtained from both mine sites correlate with theoretical and photoelastic multiple-seam models.

multiple-seam extraction, pillar strength, modeling, coal mining


Evaluates proposed guidelines, rules, and suggested practices to be used in the design and construction of surface structures and underground utilities to minimize subsidence damage due to underground mining.

vertical displacement, horizontal displacement, surface structural damage, subsurface structural damage, surface subsidence control, architecture, utilities, prediction, engineering, construction, coal mining


Describes subsidence laws in the U.S., including Public Law 95-87; background information is provided on physical, economical, and psychological effects of subsidence.

law, government, economics

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Chugh, Y. P., J. Bauer, C. Bandopadhay, C. Bollier. Subsidence Prediction Due to Auger Mining of Coal Pillars. Workshop on Surface Subsidence Due to Underground Mining, Morgantown, WV, 1981.


rock mechanics. Floor stability, coal mining, mine design


Expansion-shell rock bolts are a primary means of roof support in U.S. coal mines. The capacity to support the roof, however, is diminished or lost when the bolts lose their installed tension. Roof shales are sensitive to changes in moisture condition. Weathering effects in shaly roof rocks can cause load loss of roof bolts through anchorage creep and slippage.

rock support, roof stability, rock mechanics, coal mining


abandoned mines, room-and-pillar, geologic features, hydrology, surface structural damage, rock mechanics, instrumentation, coal mining


Contains 26 technical papers on ground control practices in coal and noncoal mines.

room-and-pillar, coal mining, mine design, mine safety, ground control, roof stability, bumps, metal mining, rock mechanics, roof support, pillar strength, modeling, monitoring methods, abandoned mines, monitoring equipment, backfilling


ground control, coal mining


construction, surface structural damage


This study documented the effects of underground coal removal on groundwater levels at selected mine sites in northern West Virginia, as observed from water wells, springs, and streams. This research should be useful to coal companies and regulatory agencies as an aid in recommendations for future water well locations and specifications in areas of existing or proposed underground coal mines.

subsurface water, surface water, hydrology, coal mining


Gives a general description of sand and granulated slag flushing, under German towns. Benefits included a substantial increase in coal extraction, no subsidence at the surface, and prevention of fire.

backfilling, mine fires


hydrology, mine safety


Describes the area and the damages at the scene of a large subsidence event; covers how utility companies met the problem.

coal mining, utilities, surface structural damage, pillar extraction


metal mining, mine design, room-and-pillar

Clemens, J. M. Monterey No. 1, A Modern Coal Mine. Mining Follows the Quadrant Plan. Coal Mining and Processing, v. 9, No. 6, 1972, pp. 38-43.
Details of roof support and other parts of the mining operation at the Monterey coal project in southern Illinois are described. Only half of the seam was extracted, leaving pillars for support.

- roof support, mine design, mine operation, pillar strength, room-and-pillar, coal mining, active mines

- Early development of coal mining in Scranton Pennsylvania is described, including agreements between coal companies and townspeople regarding compensation for and protection against surface structural damage as a result of subsidence.
- surface structural damage, anthracite, coal mining

Coal Age. Hydraulic Stowage at Home and Abroad. v. 25, 1924.
- This article is a general discussion of hydraulic stowing methods and application in various countries; it includes a detailed discussion, by Charles Enzian, of Griffith's proposal to blast the roof down and blast the floor up to form supporting pillars.
- backfilling, coal mining

- Discusses methods of transporting coal preparation waste, including a brief mention of hydraulic transport for both surface and subsurface disposal.
- mine operation, mine waste, backfilling, coal mining

- Presents longwall mining equipment and procedure, including its advantages and disadvantages as used in the U.S.
- longwall, mine design, mine operation, coal mining

Coal Mining and Processing. How to Calculate Factors in Mining Subsidence. v. 4, No. 5, 1967, pp. 28-33.
- The critical factors in mine subsidence and their effect on the surface are discussed in this article.
- mine design, backfilling, mine waste, time factor, coal mining

- Discusses the components involved in the vertical and horizontal movements within a subsidence trough.
- vertical displacement, horizontal displacement, coal mining

- coal mining, subsidence research

- Presents a pillar loading prediction method. Includes measurements of pillar stresses in iron mines and uranium mines.
- prediction, pillar strength, metal mining

- Many different variables were used to derive new designs for pillars, both in the laboratory and in the field.
- pillar strength, mine design, room-and-pillar, rock mechanics

- rock mechanics

- roof bolting, ground control, rock mechanics

- Formulates mathematical subsidence-prediction methods for underground mining operations; these methods can be used to calculate subsidence over flat-lying ore bodies, steeply dipping veins, and massive ore bodies that lead to cover caving.
- vertical displacement, horizontal displacement, rock mechanics, prediction, mathematical modeling

The mechanics of pillars is discussed from three aspects: pillar load, pillar strength, and the reaction of the roof and floor to pillar stresses.

rock mechanics, pillar strength, ground control, mine design


rock mechanics


The Bureau of Mines investigated subsidence caused by recent underground mining, estimated the extent of damages, and formulated a procedure for evaluating subsidence costs.

mitigation, economics, surface subsidence control, active mines


subsurface water, hydrology, longwall, coal mining


Describes a pumped-slurry backfilling demonstration project for abandoned mine workings. Also contains background information on other hydraulic backfilling methods.

backfilling, economics, ground control, abandoned mines, coal mining


Subsidence of the land surface over abandoned underground coal mines is a continuing problem in Colorado Springs. Subsidence events pose varying problems depending on subsidence type, local geology, and proximity to buildings and other improvements. abandoned mines, backfilling, surface structural damage, foundations, coal mining, geologic features


tab testing


abandoned mines

Colliery Engineering. Flushing Anthracite Workings. v. 33, 1913, p. 537.

Describes the first uses of hydraulic backfilling of anthracite mines using culm. Both remote and controlled flushing were used for roof support, to prevent subsidence and allow pillar removal.

backfilling, anthracite, coal mining, roof support, pillar extraction

Colliery Engineering. Effect of Coal Mining on the Surface. v. 33, May 1913, pp. 548-552; v. 33, June 1913, pp. 617-622.

surface subsidence damage, coal mining


Two methods of controlling surface subsidence are covered: 1.) hydraulic flushing with comparatively fine-grain material, and 2.) manual and mechanical stowage of material.

backfilling


backfilling


backfilling

This article describes the status of hydraulic backfilling in Poland at the time.
backfilling

backfilling

backfilling

backfilling

backfilling

Colliery Engineering. Stowage Dirt Transport. v. 34, No. 399, May, 1957, p. 221.
backfilling

Colliery Engineering. Steel Bars and Stowing. v. 34, No. 398, April, 1957, p. 176.
backfilling

backfilling

backfilling

This article describes hydraulic backfilling operations in Poland where seams are up to 79
feet thick.
backfilling

backfilling

Colliery Engineering. Age Croft Colliery. v. 37, No. 439, Sept., 1960, p. 387; v. 37, No. 440,
backfilling

backfilling

backfilling

backfilling

backfilling, coal mining

Colliery Engineering. Coal From Bilston Glen. v. 39, No. 461, July, 1962, p. 272; v. 39, No. 462,
backfilling, coal mining

backfilling

backfilling

This article includes a comparative chart illustrating the purpose of backfilling, increase in
production, fill material, and quantity and particle size of fill for the mine.
backfilling

Discusses the rights of railway owners and mineral owners and the English law of 1845.
historical, law, railways
backfilling


backfilling

backfilling, coal mining

A partial extraction system to be used in England is described. The seam is 20-30 feet thick, at a depth of 2,100 feet.
surface structural damage, partial extraction

An example is given of using hydraulic sand backfilling under pressure to fill old mine voids in Great Britain.
abandoned mines, backfilling

surface subsidence control

instrumentation, monitoring methods, survey methods, survey data processing

land-use planning, environment, coal mining

Chapter 5 describes the surface instrumentation used to measure vertical and horizontal movement and extent of surface subsidence. Results are then compared with results of predictions made by the National Coal Board of Britain.
vertical displacement, horizontal displacement, monitoring design, monitoring installation, monitoring equipment, survey methods, survey equipment, survey data processing, rock mechanics, longwall, National Coal Board, coal mining

mine design, ground control, longwall, roof stability, roof support

engineering

Concrete and Construction Engineering (London). Large Reservoir Designed for Mine Subsidence. v. 46, No. 12, 1951, pp. 353-358.
construction, hydrology, surface water

construction, foundations

construction, surface structural damage

prediction, roof stability, coal mining, geologic features

Coal mining, rock mechanics, longwall


Coal mining, rock mechanics, longwall


Coal mining, rock mechanics, longwall


Coal mining, longwall, surface subsidence damage


Outlines experience gained during a feasibility and demonstration study of longwall coal mining in the Illinois Basin. Geotechnical investigations included a premining study to review the previous attempts at longwall mining and to perform in situ rock mechanics tests. Results were used as a basis to formulate recommendations for the longwall supports to be used in the demonstration. TDR (Time Domain Reflectometry) was used in the monitoring program.

Longwall, engineering, rock mechanics, geotechnical, instrumentation, coal mining


Discusses the history and development of longwall mining in Illinois, including equipment, roof supports, and present practice.

Longwall, mine design, roof support


This report gives information on the installation, monitoring, and evaluation of three subsidence monitoring instrument systems: structure performance, performance of supported systems, and performance of caving systems. A comprehensive study of 12 instruments was conducted.

Monitoring design, monitoring installation, monitoring equipment, survey methods, survey equipment, survey data processing, instrumentation


Presents guidelines for the design and implementation of a comprehensive subsidence monitoring program.

Monitoring design, monitoring equipment, survey methods, survey equipment, longwall, horizontal displacement, economics, ground control


Summarizes subsidence research performed at a mine site in West Virginia, with a generalized geological description of the site to allow comparison of data with those of similar sites.

Monitoring design, monitoring installation, monitoring equipment, survey methods, survey equipment, instrumentation


Longwall, coal mining, monitoring methods


Deals with stresses contained within rock masses both before and after excavation, and with energy released as a result of underground excavation. The main emphasis is on calculation of stresses and not with actual physical layouts of mines.

Rock mechanics


Pillar strength, ground control, in situ testing, coal mining


This report consists of an historical summary and bibliography of foreign technology concerning backfilling as a means of limiting subsidence.

Cooper, R. E. Discussion on Subsidence Due to Coal Workings. Institution of Civil Engineers, Minutes of Proceedings, v. 135, 1898, pp. 132-135.


The field measurement of surface subsidence presents many difficulties. The use of the usual survey techniques yield a static, or instantaneous picture of the displacements along the axis of measurement. However these are not necessarily capable of analysis, especially if the line is either multi-directional or, being uni-directional, is oblique to the developing contours of subsidence. The experience gained in a field scheme for the absolute measurement of tilt and strain was useful in the design and use of the apparatus that is described in this article.


Results of unconfined compression tests are given for over 200 sample cylinders incorporating mine tailings with cement or cement and dispersant.

The Essential Subsidence Factors


including development of shield faces and other technology. This state-of-the-art report will assist in establishing criteria for roof support selection.

roof support, longwall, ground control, roof stability, mine design, mine operation


Poland has achieved high coal production despite unfavorable mining and geological conditions by introducing new and original solutions to the mining practice. This paper deals only with surface subsidence and protection against mining influences in the Upper Silesian Coalfield.

H. Longwall, surface structural damage, mine design, pillar extraction, geologic features, coal mining


rock mechanics, lab testing


Examines the application of two numerical methods (the finite element method and the displacement discontinuity method) to practical examples in the simulation of the behavior of mining excavations in the Taquari-Vassouras Mine in Brazil.

testing, finite element method, computer, rock mechanics, lab testing, in situ testing, non-metal mining


pillar strength, mine design, rock mechanics


This paper examines the use of mechanistic models.

vertical displacement, horizontal displacement, modeling, profile function


modeling


modeling


A comprehensive research effort was directed toward improving ground stability in the Humphrey mine and nearby mines having similar roof conditions.

surface subsidence control, roof stability, coal mining


Simulated subsidence phenomena using finite element models is correlated to actual field data from Britain and the United States.

continuum mechanics, finite element method, elastic theory, modeling


Compares a mathematical subsidence-prediction model with field data obtained over longwall and room-and-pillar mines in southwest Pennsylvania.

vertical displacement, mathematical modeling, prediction, longwall, room-and-pillar, survey data processing, modeling, coal mining


coal mining, rock mechanics, mine design

coal mining, roof stability


Uses the results of a subsidence survey taken over a room-and-pillar panel in northern West Virginia to compute ground strains with the use of a numerical model. Also included are short discussions on geology, mining method, the survey network, and observation procedures.

coal mining, roof stability, vertical displacement, horizontal displacement, monitoring design, monitoring installation, monitoring equipment, survey methods, survey equipment, room-and-pillar, prediction


seismic, coal mining


roof stability, ground control, room-and-pillar, geologic features


roof stability, room-and-pillar, ground control, coal mining, geologic features


rock mechanics, longwall, coal mining


pillar strength, coal mining


This bulletin deals with the history and condition of mining operations in the Scranton, PA, area.

backfilling


The geologic and geographical distribution of sand in the Northern Appalachian Basin was reported.

backfilling


modeling, roof stability


construction, surface structural damage, coal mining, roads


coal mining


ground control
Describes method of introducing culm and water at the Black Diamond Colliery, near Kingston, PA.
backfilling, roof support

surface structural damage

fluid extraction, subsurface water

hydrology

lab testing, floor stability, soils

mine design, ground control, roof stability, mine waste, longwall

hydrology, coal mining

fluid extraction, survey methods

Regional subsidence occurred in the Texas Gulf Coast area due to oil and groundwater withdrawal, resulting in consolidation of clay strata by increasing intergranular pressure.
fluid extraction, surface water, subsurface water, hydrology

survey methods

roof support, overburden

abandoned mines, historical


Presentss measurements from 2 1/2 years' monitoring of subsidence from sulfur mining in the Gulf Coast area. Sulfur extraction from the cap rock of salt domes has produced the horizontal movement.
rock mechanics, non-metal mining, survey data processing, monitoring methods, horizontal displacement

mine design, tunnelling, roof support

literature search, coal mining, metal mining, non-metal mining, fluid extraction

backfilling

This paper recommends that buildings constructed in subsidence-susceptible areas should be designed such that they can be readily raised to their original level.
surface structural damage, mitigation, construction

prediction, computer

multiple-seam extraction, subsurface subsidence damage

longwall, roof stability, geologic features, coal mining

roof stability, floor stability, longwall, geologic features, coal mining

photography, surface subsidence damage, coal mining

Discusses pillar loading, spacing, size, shape, and resulting pillar strength.
pillar strength

prediction theories

reclamation, abandoned mines, land-use planning

non-metal mining, abandoned mines

modeling, rock mechanics

hydrology

backfilling

mine operation


seismic


Describes the results of subsidence survey research performed in 1958 in Durham, England, with monitoring network design and surface/underground development procedures also included.

surface structural damage, mine design, monitoring design, monitoring methods, survey methods, survey design


fluid extraction, hydrology


fluid extraction


fluid extraction


rock mechanics


This paper identifies the steps necessary to establish a more efficient and effective program for the abatement of coal-mine related environmental problems.

reclamation, environment, abandoned mines, coal mining


Describes advantages of this method in a mine which had problems of steep gradient and frequent mine fires.

coal mining, backfilling, mine fires, geologic features


roof support, ground control, mine safety, coal mining


mine design, ground control


This paper presents readers with recommendations for choosing coaxial cables appropriate for mining applications of Time Domain Reflectometry (TDR) to monitor rock mass movements. Mining applications are illustrated with examples and the operating principle of TDR is discussed briefly.

monitoring equipment, monitoring installation, instrumentation


environment, land-use planning, prediction, roof stability, multiple-seam extraction, profile function, influence function, surface structural damage, room-and-pillar


Describes the results of surface surveys of subsidence above and adjacent to coal pillars left to protect three gas wells.

mine waste, pillar strength, horizontal displacement, vertical displacement, utilities, survey data processing, survey methods

Drent, S. Some Considerations on the Connection Between Time-Curves and the Thickness of the

overburden, time factor, coal mining, geologic features


Describes the non-carboniferous overlying strata in the South Limburg coalfield.


prediction


pillar extraction


subsurface water, hydrology, coal mining


floor stability, coal mining


land-use planning, coal mining, subsidence research


covers the geology of Illinois, the areas undermined, the mining methods used, the types of subsidence and the effects of subsidence, all in language easy to understand.

surface structural damage, subsurface structural damage, construction, insurance, coal mining, historical


The U.S. Bureau of Mines backfilled abandoned mines at selected sites in southwestern Illinois in an attempt to support failing mine openings. The Illinois State Geological Survey assisted the Bureau by developing geologic and engineering information. As part of this investigation, television probes of fifteen injection probes in Belleville augmented conventional methods of study.

abandoned mines, backfilling, monitoring equipment, coal mining


surface subsidence damage, coal mining


The Illinois Mine Subsidence Research Program was initiated in 1985 to develop guidelines for mining to control and mitigate adverse effects on prime farmland by underground coal mining while maximizing coal recovery of coal resources.

coal mining, subsidence research, agriculture


dominography, backfilling, abandoned mines, coal mining


cal mining, environment


cal mining


cal mining


cal mining


cal mining


cal mining


cal mining


environment, cal mining


A discussion of average and maximum stress distributions as a function of the shape of openings and as percent of coal recovery.

pillar strength, coal mining


rock mechanics, modeling


roof stability, floor stability, geologic features


photography, surface subsidence damage, geologic features


surface subsidence damage
Discusses backfilling of active mines by various processes including hand stowage, hydraulic, pneumatic, and a combination of hydraulic and pneumatic stowage.
backfilling, active mines

multiple-seam extraction, coal mining

historical, coal mining

economics, environment, surface subsidence damage

instrumentation, monitoring equipment

mine design, mine operation

survey data processing, lab testing, coal mining

Extraction of soluble minerals, whether by natural or man-induced processes, can result in localized land-surface subsidence and more rarely sinkhole formation. This report summarizes experience in ground subsidence and collapse over cavities formed by either natural or artificial means in saline rocks.
non-metal mining, surface subsidence damage

coal mining, mine design

prediction

coal mining, remote sensing, photography, surface subsidence damage

room-and-pillar, high-extraction retreat, coal mining

geologic features, overburden

A geographic natural resources computer database was modified to accept data files created from subsurface geological and mining information and remote sensor data. The result was a conceptual three-dimensional model of the study site in the Illinois Coal Basin.
computer, room-and-pillar, prediction, land-use planning, longwall, modeling, coal mining

A brick building was successfully constructed over an area liable to subside. The foundations were equipped with concrete rafts and the brickwork reinforced by a band of steel.
utilities, surface structural damage, foundations, construction

utilities, engineering

mine design, rock mechanics, in situ testing

This paper states that modern subsidence monitoring should include the interdisciplinary tools from soils engineering, geophysical engineering, geological engineering, geodetic engineering, mathematical and electrical engineering data processing handling and modeling methods. The main emphasis is on current methodology in geodesy and geodynamics.
sloas, engineering, geophysical methods, remote sensing, survey design, survey equipment, survey methods, survey data processing, monitoring design, monitoring equipment, monitoring installation, monitoring methods, coal mining

ground control, coal mining

Describes the danger of subsidence to surface property; also covers attempts at backfilling.
backfilling, surface subsidence damage, anthracite, coal mining, historical

The Bunker Hill Mining Co., Kellogg, ID, changed from rock waste to sand backfilling.
backfilling, mine waste

Describes the use of eight- to twelve-inch diameter caissons and grade beams for support of a new home, located 30 feet above an abandoned mine in Pennsylvania.
foundations, room-and-pillar, abandoned mines, engineering, surface structural damage, coal mining

Discusses the lack of legal responsibility at that time among mine operators for surface subsidence damage.
mine operation, law, room-and-pillar, historical, coal mining

Describes pressure grouting procedure used by the U.S. Army Corps of Engineers to reconsolidate an area beneath a proposed hospital in Pennsylvania.
backfilling, abandoned mines

An induced subsidence operation was designed to lower the floor of Duisberg Harbor, to allow renewed efficient use of the harbor.
surface water

hydrology, surface water


This bulletin reviews the history of hydraulic mine filling in active mines and its application for fire control, roof support, pillar reclamation, as well as disposing of spoil and alleviating stream pollution.
roof support, pipelines, room-and-pillar, backfilling, economics, environment, mine fires, mine waste, active mines

45
Enzian, C. Mine Caving Prevented by Hydraulic Backfilling. Coal Age, April 4, 1914, p. 555. Describes the advantages of hydraulic backfilling, including pillar reclamation, mine waste disposal, and fewer environmental problems.

backfilling, mine waste, environment, coal mining


This paper is a guide for backfilling mines with coal ash to provide support and minimize mine subsidence.

backfilling, coal mining


longwall, hydrology, surface water, subsurface water


Laboratory tests of coal samples to determine compressive strengths are discussed.

pillar strength, ground control, lab testing, coal mining


cracking, coal mining, pillar strength


cracking, rock mechanics


ground control, coal mining, pillar strength


roof support, lab testing


in situ testing, roof support


rock mechanics, overburden


backfilling


prediction, coal mining


surface subsidence damage, oil extraction, non-metal mining


survey methods


rock mechanics, mine design, lab testing


roof bolting, ground control


Felton, J. R. Some Notes on a Visit to Germany. Trans., Inst. of Min. Eng., v. 76, Jan., 1929, p. 256.


Production may approach one million tons per year from one longwall according to the results of research presented. Several methods of roof support were developed, including yieldable arches, yieldable legs and beams, and roof trusses.

cold mining, longwall, yielding supports, roof support


Investigations were made in two beds of coal separated by 71 ft. of rock and mined two years apart by the longwall method.

longwall, multiple-seam extraction, coal mining


modeling, oil extraction


This mining system leaves small yielding pillars which are meant to deform plastically and produce controlled subsidence. Conventional room-and-pillar mining equipment is used with longwall roof supports.

longwall, shortwall, room-and-pillar, roof support, roof stability, mine design, yielding supports


monitoring design, monitoring equipment, monitoring installation, monitoring methods, instrumentation


mine design


This paper reviews current mining subsidence research at the Department of Mining Engineering, University of Nottingham. Special attention is being devoted to prediction of ground movements between the mining horizon and the surface using physical and computer-based models.

modeling, computer, geologic features, finite element method, National Coal Board, coal mining


presents research conducted to study the influence of incomplete convergence at the edge of workings on surface subsidence. Data were collected in Germany from mines where backfilling is used.

vertical displacement, time factor, backfilling


Reviews the problems of subsidence from anthracite and bituminous mining.

equipment, government, law, coal mining, anthracite


backfilling


Discusses the mechanics and advantages of hydraulic packing in Belgium, shortly after the introduction of the system.

backfilling


mine waste


mine waste, rock mechanics, geotechnical


pillar strength, ground control, engineering


longwall, roof stability, roof support, mine operation


hydrology


rock stability, coal mining


rock mechanics


Discusses the use of hydraulic flushing to stabilize water-saturated overburden during the mining of a thick brown coal seam.

backfilling, coal mining


Discusses pneumatic backfilling with regard to air pressure, particle size and stowing machines.

backfilling


One chapter covers strata control and surface subsidence.

ground control


Fluid extraction, photography, remote sensing, prediction


determination, fluid extraction


Describes the use of hydraulic stowing in 1909 to prevent surface subsidence.

floor stability, geotechnical, coal mining


This mine design method draws together three distinct elements of technique—finite element simulation, stress control via yielding pillars, and specialized techniques for geomechanical behavioral monitoring of underground openings.

mine design, finite element method, modeling, longwall, roof support


surface structural damage


utilities, coal mining


subsurface water, coal mining, longwall


fluid extraction


This paper illustrates that yield pillars in conjunction with abutment pillars offer improved roadway stability and improved resource recovery. Results from the experimental areas have led to yield pillar designs being used to establish gate roads and main air courses.

room-and-pillar, instrumentation, mine design, longwall, yielding supports, pillar strength


These methods range from foundations offering maximum resistance to earth movements to articulated frames offering little or no resistance.

vertical displacement, horizontal displacement, surface structural damage, surface subsidence control, architecture, foundations, engineering


Details the interaction between soils and horizontal building foundation surfaces on which loading resulting from ground movements is delivered in the form of shearing stresses.

surface structural damage, soils, foundations


surface structural damage, construction


surface structural damage


prediction, modeling, subsurface water


land-use planning, coal mining


utilities, coal mining

surface structural damage, land-use planning, coal mining


Contains laws enacted in 1966 to protect the public health, welfare, and safety by regulating the mining of bituminous coal.

law, mine design, government, mine safety, mine operation, surface structural damage, coal mining


Investigates the subsidence caused by two longwall panels, with data analyzed in terms of zone of advance influence and delay angle of maximum subsidence velocity.

surface structural damage, mine design, longwall


Presents the results of a rock mechanics instrumentation program designed to determine the rock mass response due to longwall mining of a thick coal seam, with details on the geology and instrumentation.

monitoring design, monitoring installation, monitoring equipment, survey methods, survey equipment, rock mechanics, longwall, roof support, coal mining


longwall, overburden, coal mining


longwall, coal mining, overburden


longwall, coal mining, overburden


longwall, coal mining


Presents procedures for monitoring subsidence in rugged terrain, describing the network layout and design, as well as monument construction and installation.

monitoring design, monitoring installation, monitoring equipment, survey methods, survey equipment, survey data processing, longwall, coal mining


Describes the procedures and equipment used in installing and removing a subsidence monitoring network in rugged terrain. Also contains procedures for obtaining special service use permits from the Forest Service.

monitoring design, monitoring installation, monitoring equipment, survey methods, survey equipment, longwall

Germanis, E., S. Valliappan. Mining Subsidence at the Graving Dock Site, New Castle. Pres. at Symp. on Recent Developments in the Analysis of Soil Behavior and Their Application to Geotechnical Structures, Univ. of New South Wales, Australia, 1975, 14 pp.

surface structural damage


soil mechanics
pillar extraction, coal mining

longwall, roof support, mine design

surface structural damage, coal mining

Public opinion is less and less willing to tolerate the various harmful effects of mining subsidence. From another standpoint, among the financial costs that coal mining has to carry, those incurred in compensation for damage can become a major cause for concern. The object of this report is to try to identify the main potential effects of mine workings, both on finances, and on the environment itself, in order to further the debate.
coal mining, economics, environment, vertical displacement, horizontal displacement, surface structural damage, hydrology, utilities, backfilling, railways, roads

fluid extraction, lab testing

foundations, engineering, construction

surface structural damage, coal mining, abandoned mines

surface structural damage, mitigation, foundations, coal mining

monitoring methods

surface structural damage, abandoned mines, coal mining


Gill, D. E. Subsidence Associated with the Mining of Bedded Deposits. The Subsidence Sub-Committee of the Canadian Advisory Committee on Rock Mechanics, Montreal, Canada, Feb., 1971, 62 pp.
rock mechanics, surface subsidence damage, subsurface subsidence damage

Subsidence was first noticed in the Long Beach Area in 1937, according to tide-gauge records, after the development of the Wilmington oil field.
fluid extraction, oil extraction

Investigates the development of a coupled finite element geomechanical-hydrology code applied to the problem of predicting ground water disturbances associated with mine subsidence. Includes analyses of hydrologic modeling.
vertical displacement, horizontal displacement, subsurface water, hydrology, prediction, finite element method, modeling

53


54


ground control, coal mining


The use of grout columns to stabilize an undermined site for the construction of an electric power station is discussed.

subsurface structural damage, utilities, backfilling


Contains a selected history of mining and mining-subsidence research in the Pittsburgh, PA, area, including descriptions of topography and geology. Also discusses subsidence control, mining, and construction methods.

surface structural damage, mine design, backfilling, room-and-pillar, ground control, backfilling, engineering, construction, geologic features, subsidence research, coal mining


Describes subsidence problems from both active and abandoned bituminous coal mines in the Pittsburgh area. Discusses protective measures including pillar support, grout columns, and backfilling.

backfilling, abandoned mines, active mines, room-and-pillar


prediction


surface subsidence damage


Describes the use of fly ash injection, grout columns, predrilled piles and caissons for support of roads and structures in an undermined power substation.

surface structural damage, foundations, utilities, backfilling


Discusses methods of controlling or preventing surface subsidence damage above active and abandoned mines. Contains annotated bibliographies.

vertical displacement, horizontal displacement, mine design, backfilling, monitoring design, monitoring installation, monitoring equipment, ground control, mine operation, literature search, active mines, abandoned mines, coal mining


surface structural damage, abandoned mines, ground control, coal mining


abandoned mines, rock mechanics, surface structural damage, room-and-pillar, economics, partial extraction, insurance, historical, coal mining


Reviews the development of coal mining in the United States; includes a discussion on subsidence characteristics including modes, time effects, overburden thickness, and lithology.

vertical displacement, horizontal displacement, backfilling, abandoned mines, longwall, room-and-pillar, historical, time factor, economics, coal mining

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abandoned mines, subsidence research


longwall, coal mining


fluid extraction, hydrology


fluid extraction, hydrology


geophysical methods


backfilling, coal mining


roof stability, coal mining


In an experimental mine, tests were made by applying a pressure from a hydraulic jack against a coal face.

pillar strength, in situ testing, coal mining


Laboratory and in situ strength measurements were performed on specimens of Pittsburgh sandstone, Pittsburgh coal, and mine props.

roof stability, roof support, mine waste, rock mechanics, lab testing, in situ testing, coal mining


Includes a description or review of tests run by various investigators on the properties of coal and coal-mine strata.

floor stability, mathematical modeling, pillar strength, time factor, lab testing, overburden, coal mining


 Discusses floor heave, timber failures, the effect of overlying sandstone, and the magnitude of surface subsidence with regard to roof studies in the Crucible Mine.

roof stability, overburden, floor stability, coal mining


Tests for compressive strength and other properties were performed in situ on seven small coal pillars.

pillar strength, in situ testing, floor stability, coal mining


roof stability, roof support, coal mining


Presents results of five compression tests on in situ pillars.

pillar strength, rock mechanics, in situ testing, coal mining

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  pillar extraction, coal mining

  abandoned mines, coal mining

  modeling

  Suggests application to modified longwall system to recover more coal. This method requires suitable terrain and plenty of available fill.
  backfilling, longwall, anthracite, coal mining, geologic features

  Describes the first use of hydraulic backfilling for subsidence prevention and roof control in anthracite coal mines.
  backfilling, roof stability, anthracite, coal mining

  Griffith's patent was a proposal for blasting the roof and/or floor and allowing the fractured rock, which bulks and occupies a larger volume, to remain in place as permanent support pillars and to act as a dam for hydraulic backfilling materials.
  backfilling, roof support

  Includes mine plans and cross sections of the Scranton area; discusses strength and compressibility of anthracite pillars and backfill materials.
  backfilling, mine waste, historical, roof support, pillar strength, coal mining

  A series of experiments were carried out on limestone, marble, and quartz samples to investigate the physical processes resulting in rock deformation.
  rock mechanics, non-metal mining, lab testing

  Surface effects and subsidence parameters of mining the upper four seams at the Noril'sk Coalfield, where permafrost extends to 200 meters, are discussed.
  multiple-seam extraction, surface subsidence damage

  floor stability, lab testing

  floor stability, lab testing

  This series of articles gives a short history of subsidence investigations and early theories, principally those from Germany.
  historical, prediction, overburden, subsidence research, coal mining

  coal mining, survey methods

- Provides a critical analysis of European subsidence prediction methods, including both early and modern theories.
- vertical displacement, horizontal displacement, prediction, prediction theories, ground control, historical


- Discusses the theory of arch support; summarizes other papers presented in this field.
- overburden

Grond, G. J. A. Ground Movements Due to Mining. Colliery Eng., v. 34, Jan., 1957, pp. 157-158; v. 34, June, 1957, pp. 197-205.

- surface subsidence damage, overburden


- subsidence research, government, law


- land values, agriculture, economics, coal mining


- In a survey of Illinois agricultural extension advisers, subsidence was reported in 31 counties. The most frequently reported problems were: standing water, depressions, disruption of surface drainage, broken tile lines, and reduced crop yields.
- agriculture, surface subsidence damage, economics, surface water, subsurface water, utilities, coal mining


- economics, agriculture, coal mining


- soils, agriculture, environment, law, surface subsidence damage, coal mining


- multiple-seam extraction, mine design, subsurface water


- Describes mechanics of sand filling in gold mines of South Africa.
- backfilling, metal mining, roof support


- Results of computer modeling of surface subsidence above longwalls at three different collieries are described. A computer program based on the displacement discontinuity method has been utilized to simulate subsidence profiles and maximum subsidence. Modeling of static and dynamic profiles were carried out separately; results show a linear relationship between elastic parameters of the surrounding rock, the thickness of dolerite and the face advance.
- computer, modeling, longwall, prediction, finite element method


- surface subsidence damage


- roof support, ground control, roof bolting


Requirements for full extraction in underground coal mining call for inexpensive, safe techniques to be competitive with conventional methods. Longwall and shortwall systems are to some extent employed for this purpose. Another method would be rib pillar extraction and pillar extraction. These methods are compared with each other with respect to procedure, equipment, safety, roof control, investment, output, performance, costs.

longwall, shortwall, economics, pillar extraction, roof stability, coal mining, mine design


Describes work done at the University of Nottingham by Prof. R. Hill; his conception of a longwall working was a horizontal crack in an infinite medium.

continuum mechanics theories, ground control, elastic theory, longwall, modeling


elastic theory, modeling, in situ testing


rock mechanics, in situ testing


Hakelberg, F. Flexible Bituminous Bases for Areas of Mining Subsidence. Strassen-Asphalt und Tiefbau-Technik, v. 9, 1956, p. 657 (in German); also Road Abstract No. 247, Mar., 1957 (in English).

surface subsidence damage, construction


longwall, roof stability, roof support


roof stability


reclamation, environment, soils, surface water, subsurface water, coal mining


Evaluates 33 methods for predicting subsidence over caved longwall coal mines.

vertical displacement, horizontal displacement, survey methods, survey equipment, prediction, longwall, prediction theories, coal mining


Examines empirical and phenomenological methods for predicting subsidence over longwall panels.

vertical displacement, horizontal displacement, longwall, prediction, prediction theories, coal mining


engineering, construction, architecture


survey data processing


roof stability

floor stability


Describes and supports Griffith’s process of blasting up the floor and blasting down the roof to produce roof supports and dams for hydraulic flushing.

backfilling, roof support, coal mining


surface subsidence damage, coal mining


surface subsidence damage


The desire for land close to the central building district and the consequent escalation in cost led to a reappraisal of undermined ground in this area. This paper describes the investigation and treatment of a site required for development of a multi-story building. The treatment method chosen enabled physical inspection of the actual workings and the stabilization comprised the construction of concrete buttresses followed by specialized grouting.

abandoned mines, metal mining, historical, engineering, construction, surface structural damage, geotechnical, foundations


in situ testing


in situ testing


surface subsidence damage, modeling, subsurface water, fluid extraction


Discusses the problem of highway subsidence and considers the possible application of seismic and acoustic emission/microseismic (AE/MS) techniques for monitoring such subsidence. References a recent monitoring study at New Cumberland, PA. Results are considered to be directly relevant to problems of karst- or mining-induced subsidence.

roads, geologic features, coal mining, monitoring methods, monitoring equipment, monitoring design, seismic, utilities, instrumentation


ground control, bumps, monitoring methods


seismic, longwall, monitoring methods, coal mining


Discusses backfilling, removing pillars under surface water, and management of water in mines.

surface water, pillar extraction, backfilling, mine operation, coal mining


Several papers are included with topics covering prediction methods, monitoring techniques, mine design, hydrological effects, and structural problems as related to mine subsidence.
vertical displacement, horizontal displacement, surface structural damage, subsurface structural damage, surface water, subsurface water, mine design, monitoring design, monitoring installation, survey methods, survey equipment, survey data processing, prediction theories, monitoring methods


fluid extraction


rock mechanics, ground control, lab testing


longwall, coal mining, mine operation


land-use planning, coal mining


The underground coal mines that are currently of concern to subsidence professionals in Colorado were generally mined between 1860 and 1960. Careful study of dates of mining, production records, mine maps, and interviews with former miners can aid in predicting current mine conditions.

historical, abandoned mines, room-and-pillar, coal mining


backfilling, roof support, anthracite, coal mining, yielding supports


rock mechanics, modeling, pillar strength, ground control


coal mining, roof stability


longwall, surface subsidence control, ground control


longwall, surface subsidence control, ground control


metal mining, engineering


metal mining, engineering


metal mining


metal mining

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surface structural damage, architecture

surface subsidence damage

lab testing, in situ testing, rock mechanics

Discusses the mechanics of mine subsidence, effects of subsidence on structures, as well as subsidence due to mining of material other than coal, and construction considerations to offset the effects of subsidence.
surface structural damage, engineering, foundations, coal mining, metal mining, non-metal mining

surface subsidence damage, subsurface subsidence damage, overburden

horizontal displacement, ground control, descriptive theories, backfilling, room-and-pillar, coal mining

Although at the time (1920) the hydraulic stowing of mines to minimize subsidence was used successfully in Europe, South Africa, and Australia, the English-speaking countries were slow to adopt this method.
backfilling, angle of draw, historical, surface water, coal mining

Colorado Geological Survey Special Publication 31, Department of Natural Resources, Denver, CO, 1986.
Several of the abandoned underground coal mines of the Boulder-Weld Coalfield that are located near Marshall, Colorado were studied to characterize the possibility of subsidence and the hazard posed by these mines, including the few that are on fire. abandoned mines, mine fires, surface structural damage, utilities, pipelines, surface water, historical, remote sensing, photography, survey design, survey methods, monitoring design, monitoring methods, coal mining

Describes a field trip in the Denver area, focusing primarily on the hazards and problems of land use associated with abandoned underground coal mines and their potential for subsidence and spontaneous combustion.
abandoned mines, land-use planning, mine fires, surface subsidence damage, coal mining

rock mechanics

roof support, roof stability

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Hesse, A. W. What Shall We Use For Roof Support in Coal Mines? Coal Age, v. 5, Feb. 28, 1914, p. 354. This article compares the advantages and disadvantages of oak, pine, chestnut, T-rails, and I-beams.

roof support, coal mining


room-and-pillar, mine design, rock mechanics


room-and-pillar, mine design, geotechnical

Hibberd, P. Transference of Ground Movement to Surface Structures. Trans., Inst. Mining Engineers, Oct., 1961. This paper is a record of research from three sites in Scotland, where various types of buildings were damaged by subsidence. Theoretical aspects are included as well as field data.

surface structural damage, foundations


abandoned mines, coal mining


room-and-pillar


hydrology, subsurface water, coal mining


rock mechanics, roof stability, coal mining

Hill, J. L. III. Cutter Roof Failure: An Overview of the Causes and Methods for Control. U.S. Bureau of Mines IC 9094, 1986, 27 pp. Cutter roof failure is a ground control problem which exposes miners to the danger of falling roof rock and frequently results in massive roof failure. Traditional methods of control are presented, as well as innovative methods which are based on historical coal mining concepts.

roof support, roof stability, mine operation, mine design, longwall, room-and-pillar, ground control, coal mining


backfilling


describes hydraulic flushing in which fill material is transported dry to the working level where it is mixed and gravity fed to the stowing area.

backfilling, coal mining

environment, hydrology, mine waste


environment, mine waste, surface water


Conventional rotary drilling in combination with lithologic and down-hole geophysical logging has proven to be the most cost-effective method for investigating abandoned mine conditions and coal seam geometries along the Colorado Front Range.

abandoned mines, geophysical methods, overburden, monitoring methods, coal mining


tolongwall


describes prediction of ground movements caused by coal mining using a method based on functions of influence that provide influence factors through integration.

vertical displacement, horizontal displacement, prediction, computer, rock mechanics


rock mechanics, horizontal displacement, surface subsidence damage


boundary element method, modeling, tunnelling


rock mechanics, lab testing, coal mining


tolongwall, rock mechanics, overburden, coal mining


tommine design, tunnelling


The subsidence model, made of synthetic foam, consisted of several plates separated by paper strips; it was designed to study the effects of subsidence on overburden strata.

tommine design, rock mechanics, modeling, overburden


A study of the compressive effect upon adjacent remaining pillars when selected pillars were pulled in the Pittsburgh seam.

tommine mining, pillar extraction, pillar strength, in situ testing


tommine control, room-and-pillar, mine design, bumps, coal mining


rock mechanics, ground control, roof stability

Considers the support of overburden in coal mines from these aspects: load on the coal bed before mining, stress or load produced by mining, strength of coal and pillars, load capacity of the roof and floor, effect of water on roof and floor material, composition of load-bearing rocks, and safety factors.

- overburden, pillar strength, roof stability, floor stability, mine safety, coal mining


- ground control, room-and-pillar, mine design, coal mining


- Discusses yield pillar theory of entry design so that some roof problems and rock bursts are eliminated in mines at depths of 400-2000 feet below the surface.
- mine design, roof support, roof stability, yielding supports


- Uses field tests to support laboratory theories on pillar design for permanent support of overburden in coal beds. Briefly discusses the effect of water on floor rock.
- floor stability, pillar strength, mine design, overburden, coal mining, in situ testing, lab testing


- Discusses the strength of coal based on the specimen size and the least dimension of the specimen. Based on experimental data, a series of conclusions regarding coal strength are presented.
- rock mechanics, pillar strength, coal mining, lab testing


- Describes required support in the form of unmined coal beneath proposed earth dams in Pennsylvania and West Virginia. To justify recommendations presented, the current (1965) state of knowledge concerning subsidence parameters and coal strength for the area and seams in question is summarized.
- pillar strength, surface structural damage, coal mining


- Discusses the development of a formula for estimation of coal pillar strength. One of the factors involved in this formula is the coefficient of friction between the coal pillar and the adjacent rock with which it is in contact.
- coal mining, pillar strength, in situ testing


- Reviews the historical and current methods of roof control, including pillar/room dimension, rock bolting, geological considerations, and depth of overburden.
- roof stability, roof support, ground control, room-and-pillar, overburden, coal mining


- pillar strength, ground control, mine design


- rock mechanics, mine design, pillar strength, yielding supports, overburden


- roof bolting, ground control


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The State of Colorado is in the final stages of developing a Subsidence Insurance Program which will be operated by one or more private insurance companies. The state's involvement is necessitated by provisions in the federal legislation enabling the program. Also, no specific subsidence risk insurance is available in the market place today.


reclamation, law


Surface subsidence damage


Survey methods, geophysical methods


Rock mechanics, shortwall, ground control, instrumentation, monitoring methods


Extensive underground mining occurred in the Centerville area, Appanoose County, Iowa between 1850 and 1971. Coal production was exclusively from the Mystic Coal Member of the Labette Shale (Pennsylvanian). The location and extent of abandoned coal mines and known occurrences of mine-related problems in the area is documented. A map shows the location and extent of coal mines and a compilation of mine-related information including historical and physical data.

Coal mining, abandoned mines, historical, land-use planning, longwall, room-and-pillar


Coal mining, subsurface water, geologic features, mine operation


Discusses evaluation of subsidence risk/planning and engineering alternatives for adjusting to hazards resulting from subsidence related to underground mining, occurring in organic wetlands, and in karst terrains.

Vertical displacement, horizontal displacement, law, mine design, backfilling, land-use planning, environment, geologic features


Land-use planning, government, environment


Government, land-use planning, surface subsidence damage


Describes a longwall system designed specifically for a seam. Increased mine safety is noted because of this special design, and because self-advancing hydraulic roof supports were used.

Coal mining, longwall, mine design, roof support


Backfilling, mine safety


Roof stability, ground control, geologic features


A 20 inch diameter high-pressure natural gas pipeline crosses over a coal mine in central Utah. The room-and-pillar method with pillar extraction is being used to extract the coal from the seams. The pillars beneath the pipeline will not be extracted. An attempt has been made to predict subsidence in the area where pillars may collapse; a network of survey points has been installed along the pipeline to detect ground movements.
utilities, pipelines, survey methods, survey design, multiple-seam extraction, pillar strength, coal mining, pillar extraction


Hudspeth, H. M. Ground Movement in Advance of Longwalls. Iron and Coal Trades Review, v. 126, 1933, pp. 1-3. Roadways were driven in the coal in advance of the working faces of two mines. Telescoping measuring rods were used to record raise in floor and convergence of roof.

Hudspeth, H. M., D. W. Phillips. Forces Induced by the Extraction of Coal and Some of Their Effects on Coal-Measure Strata. Trans., Inst. of Mining Engineers, v. 85, 1932-33, pp. 37-57, 186-190. Describes general and mathematical considerations of fractures forming in coal measure strata. Results are given of experiments with models.


Hunter, J. Pneumatic Stowing at Bullcroft Main Colliery. Trans., Institution of Mining Engineers, v. 105, 1945-46, p. 111. Reviews packing of mined out areas in subject mine prior to utilization of pneumatic backfilling; also discusses backfilling devices and methods.


Hurst, G., F. Owen, C. Bayrac. Some Observations On the Behavior of a Large School Subject to Mining Subsidence. Colliery Eng., v. 43, July, 1966, pp. 295-301. Discusses a study of subsidence damage to a school underlain by limestone, which in turn was underlain by mine workings of two seams. The foundation of the school was constructed specially to guard against subsidence effects, but it was still damaged extensively.


pillar strength, ground control, rock mechanics, coal mining


ground control, subsurface subsidence damage, surface subsidence damage, coal mining


floor stability, rock mechanics, lab testing


roof stability, coal mining, geologic features


roof stability, coal mining


Many factors affect the reliability, accuracy, and usefulness of the results of a subsidence investigation above abandoned mines. Within control of the investigator are several organizational and data acquisition requirements which are critical to the success of the study, including mapping, drilling, down-hole geophysics, sampling and testing, a site survey, and site evaluation.

abandoned mines, monitoring methods, survey methods, geophysical methods, surface structural damage, modeling, prediction, lab testing


Impacts of subsidence are especially significant in the Rocky Mountain West where population growth and rapid community expansion have increased development pressure on significant areas of subsidence-prone ground. The present consequences of unrecognized and poorly managed subsidence hazards are much more serious in the emerging urban and suburban environment than they were in the past where they occurred primarily in agricultural lands.

reclamation, abandoned mines, historical, mine fires, surface structural damage, remote sensing, photography, backfilling, modeling, prediction, room-and-pillar, monitoring design, mitigation, architecture, surface subsidence control, land-use planning, insurance, coal mining


roof stability, mine design, geologic features


  law, government, reclamation, environment, coal mining

  Section 4.02 gives a brief description of the mine operator’s responsibilities for the treatment of subsidence due to underground mining in Illinois.
  law, mine operation, coal mining

  coal mining, surface structural damage, utilities

  law, government, mine design

Imim, H. I. Memorandum of Evidence to the Committee on Mining Subsidence. Submitted by the Council of the IME, Trans. of the Institution of Mining Engineers, London, v. 107, 1947, pp. 50-64.
  Observations and recommendations were made pertaining to subsidence legislation, legal settlements, and building construction, with respect to coal mining.
  law, construction, coal mining

  ground control, continuum mechanics theories, modeling

  This reference consists of a guidance to good practice for the civil engineer who is not a specialist in the area of ground subsidence; it is divided into seven sections dealing with the causes and effects of both natural and induced surface subsidence.
  vertical displacement, horizontal displacement, surface structural damage, subsurface structural damage, surface water, mine design, backfilling, surface subsidence control, engineering

  surface structural damage, backfilling, engineering, pillar strength

Institution of Mining Engineers. A Simple Method of Water Stowage Employed at No. 5 Pit at the Eserpelle Mines. Trans., Inst. of Mining Engineers, v. 35, 1907-1908, p. 79.
  backfilling, historical

Institution of Mining Engineers. Pneumatic Stowing at Bullcroft Main Colliery. v. 105, 1945, p. 315.
  backfilling

Institution of Mining Engineers. Effects of Stowing on Surface Subsidence. Trans., v. 107, No. 58, 1947.
  backfilling


  surface structural damage, foundations, soils

  fluid extraction

  hydrology

  backfilling

This paper described the advantages of solid packing over partial packing, with a description of a German method which was being tried in England.

backfilling


Jack, B., J. J. Steijin, N. C. Gay. The Effect of Subsidence as a Result of Shallow Mining Operations on Surface Structures--A Quantitative Case Study. Monitoring for Safety in Geotechnical Engineering, Aug. 10, 1984, pp. 67-78. describes the effects of subsidence on structures at ground surface, as a result of shallow coal mining operations

survey methods, geotechnical, photography, instrumentation, surface structural damage, longwall, monitoring equipment, coal mining

Jack, B. W. Case Studies of the Effects of Surface Subsidence on Gravel and Provincial Bituminous Roads. SANGORM Symposium, Oct. 21, 1986, Sandton, South Africa, pp. 97-114. International Society for Rock Mechanics, South African National Group. Total extraction of coal seams can cause damage to the surface and structures undermined. Roads of various types are the predominant structures which traverse the coalfields of South Africa. Instrumentation and monitoring techniques for case studies are described and the findings given.

coal mining, monitoring methods, survey methods, instrumentation, roads


backfilling, mine waste


hydrology, oil extraction


mine operation, roof stability, coal mining


Roadway stability was studied by the placement of monitoring stations in the adjacent strata, with research concentrated in the Appin, Bulli, and Metropolitan Collieries, Australia.

instrumentation, monitoring equipment


ground control

Janes, J. R., M. T. O'Day. Shedding New Light on Longwall. Coal Mining & Processing, April, 1979, pp. 74-76.

Details a new lighting system for use at a longwall face at the Old Ben mine in Illinois. coal mining, active mines, longwall, mine operation, roof support, mine safety


Discusses the concept of "prime farmland" referred to in the Surface Mining Control and Reclamation Act (Public Law 95-87). agriculture, reclamation, law


surface water


coal mining, vertical displacement, horizontal displacement, mine design, geologic features, surface structural damage, time factor, prediction, influence function, active mines


modeling, vertical displacement, horizontal displacement


The problems of caving and underground subsidence can be considered as the failure of a highly compacted rock and its subsequent flow in the form of broken rock. The problem is complex because the propagation of failure and flow have to be considered simultaneously, the yield strength of the virgin rock and the broken rock are different; and, while under certain conditions it is sufficient to consider the virgin rock as homogeneous, the density and the yield function of broken rock are both pressure and time dependent.

rock mechanics, overburden

Jenkins, H. C. Gob-Stowing Practices. Trans., Inst. of Min. Eng., v. 81, 1931, p. 120.
backfilling, mine waste

floor stability

floor stability

floor stability, coal mining

mine design, ground control, longwall, roof stability

This paper is an extensive study of size segregation during fill emplacement by hydraulic flushing. Discusses sedimentation regimes, angle of repose, and compressive strength as related to particle size.
backfilling, lab testing

Discusses problems and practical applications of mine backfilling, characteristics and relationships between the deposited fill material and overlying ground.
backfilling, ground control

Describes the state of the art of pneumatic backfilling based on European practices, mainly from Germany.
backfilling

The subsidence over 2 longwall sections operating in the northern Appalachian coal region was monitored. Although the final subsidence profiles differed, analysis of the data indicated the same process of subsidence operated at each panel.
longwall, survey data processing, coal mining

coal mining, rock mechanics, mine design

Discusses an investigation of the surface effects of block caving used in an Arizona copper mine. Surface survey methods included reference pins, triangulation surveying, and air photographs.
survey methods, monitoring equipment, photography, surface subsidence damage, metal mining

abandoned mines, reclamation, law, environment, historical, economics

reclamation, abandoned mines, economics, coal mining

pillar extraction

rails

architectural, construction, surface structural damage


Examines method of determining displacement, strain, and stress components of ground deformation due to underground mining based upon the theory of elasticity and the principle of superposition.

vertical displacement, horizontal displacement, prediction, computer


engineering, construction, roads


backfilling, coal mining


Two case histories are presented to illustrate the geotechnical interactions occurring between relatively shallow quarrying for brickmaking materials and underground mining operations. Although the intervening vertical distances between the different quarry floors and the underground workings may differ from less than 20 metres to over a kilometre, sinkholes are a common occurrence. Brief diagnoses are made of the mechanisms responsible for the unstable ground conditions in each instance.

ground, non-metal mining, abandoned mines, subsurface water, coal mining, metal mining, surface structural damage


Since 1923, bumps have occurred in the region of the Middlesboro Syncline in Harlan County, KY. Increased production appeared to cause increased incidence of bumps.

bumps, room-and-pillar, overburden, mine design, coal mining


Minor subsidence damage to a school building and grounds in Pennsylvania prompted an investigation of the site. This investigation determined that subsidence over an abandoned coal mine was occurring and that additional damaging subsidence would occur if reclamation measures were not taken.

backfilling, abandoned mines, surface structural damage, coal mining


subsidence, ground movement, subsurface damage


Summarizes the results of a subsidence monitoring program, and provides a comparative analysis of the subsidence data collected with three popular subsidence prediction models which have been used in the region.

prediction, modeling, National Coal Board, profile function, finite element method, room-and-pillar, monitoring design, survey data processing, coal mining


mine design, ground control, longwall, roof stability, roof support


longwall, rock mechanics

mine safety, geologic features, coal mining


Discusses the use of safety pillars, backfilling, and various other methods of preventing or reducing subsidence damage.

ground control, pillar strength, backfilling, land-use planning, surface structural damage

surface structural damage, ground control

coal mining, geologic features, ground control

metal mining, surface subsidence damage

surface water, subsurface water, coal mining

Kapp, W. A. Subsidence Due to Underground Coalmining. Mine and Quarry Mechanisation, 1972, pp. 115-121.

Presents general characteristics of subsidence over underground coal mines, including subsidence mechanics, surface effects and protection, and precautions for mining under water.
surface structural damage, mine design, coal mining, surface water


surface subsidence damage


coal mining


Summarizes results of subsidence surveys over longwall, shortwall, and room-and-pillar panels in New South Wales, Australia. Relates underground extraction to surface subsidence.

vertical displacement, horizontal displacement, mine design, coal mining, longwall, shortwall, room-and-pillar

coal mining

coal mining

Coal is being mined from beneath residential areas, structures, bodies of water and other features in the coalfields to the north, south and west of Sydney. The mining layout and the local geological setting are the two main factors which influence the nature of ground movements and subsidence. Locally established empirical guidelines assist in the planning of mine layouts in areas where subsidence is an important consideration.

surface structural damage, coal mining, pillar extraction, surface water, mine design, finite element method, mathematical modeling, land-use planning


surface subsidence damage, subsurface subsidence damage, tunnelling


Describes the use of field measurements and computer-modeling techniques to develop basic relationships between longwall subsidence and related parameters. Summarizes subsidence trends of the Appalachian Coal Region, with a brief reference to the zone-area method of prediction. vertical displacement, horizontal displacement, survey data processing, longwall, computer, ground control, prediction, modeling, survey methods, zone area method, coal mining


rock mechanics, computer, zone area method, modeling


computer, prediction, modeling


zone area method, coal mining, modeling


presents a zone area method computer program designed to predict a complete subsidence profile for seam gradients up to 20 degrees. Describes the method and how the program was developed to use it for both longwall and room-and-pillar mining operations. vertical displacement, zone area method, computer, prediction, longwall, room-and-pillar, modeling


Discusses the influence of geological controls on subsidence, and the effects of subsidence on man and his environment. A historical review of rules and regulations governing subsidence-related problems is given. historical, law, environment, vertical displacement, horizontal displacement, coal mining


room-and-pillar, mine design, mine operation, high-extraction retreat, active mines, coal mining


surface structural damage


surface structural damage, coal mining

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A 16-story apartment building was constructed on a site with multiple mined-out coal seams. Surface structural damage, backfilling, multiple-seam extraction, engineering, abandoned mines, coal mining, architecture


fluid extraction


Longwall, mine design, geologic features, coal mining


roof support, ground control


surface structural damage


Longwall, roof stability, rock mechanics, mine waste


roof stability, ground control, room-and-pillar, coal mining, geologic features

Kentucky Department for Natural Resources and Environmental Protection, Bureau of Surface Mining Reclamation and Enforcement. Permanent Program Regulations for Surface Coal Mining and Reclamation Operations and Coal Exploration Operations. 405 KAR 8:040E, Sec. 26, Apr., 1982, 52 pp.

Subsidence control section covers the legal considerations of subsidence for the state of Kentucky.

law, mine operation, reclamation, environment


backfilling, metal mining


Because coalbed discontinuities often pose serious economic and safety problems in underground coal mines, criteria were documented for the recognition and prediction of discontinuities in advance of mining.

geologic features, mine design, mine safety, coal mining, overburden


finite element method, computer, modeling


coil mining, pillar strength


Analysis of subsidence in room-and-pillar mining has been made using models of various extraction ratios and overburden depths along with two types of overburden model material.

coil mining, modeling, room-and-pillar, mine design, abandoned mines, time factor, overburden

Khair, A. W., G. S. Begley, R. D. Begley. Study of Subsidence Characteristics Due to Underground Mining of Coal Using a Physical Modeling Technique. Proc., 2nd Workshop on Surface Subsidence due

This paper presents an analysis of surface subsidence characteristics in room-and-pillar mining using physical models and laser holographic interferometry (holometry). The analysis included the effect of various geometric parameters and different overburden materials and resulted in the formulation of a more realistic model material for laboratory simulation of typical geologic overburden.

modeling, coal mining, room-and-pillar, overburden


An analysis is presented of the effects of topography on quasi-static and dynamic ground movements and the severity of damage inflicted on surface structures.

geologic features, surface structural damage, subsurface structural damage, horizontal displacement, instrumentation, angle of draw, coal mining


surface subsidence damage, coal mining, mine fires


to mine operation, mine fires, lab testing, coal mining


Laboratory experiments used gelatin models to determine surface effects of mine subsidence.

to surface subsidence damage, modeling, lab testing


Details the construction, installation, and operation of two instruments designed to measure surface strain and tilt due to underground mining.

monitoring equipment, monitoring installation, monitoring methods


Three groups of subsidence factors related to longwall mining are defined by laboratory model experiments: dimensional, geological, and rate factors.

modeling, longwall, geologic features, lab testing


geologic features


This article reviews early experience and observations of subsidence in Great Britain. It points out the concern by the National Coal Board about non-subsidence damage, since in legal disputes, the burden of proof rests with the National Coal Board.

surface subsidence damage, National Coal Board, law, coal mining


to coal mining, survey data processing


mine design, mine operation, ground control


Describes monitoring techniques used to determine the effectiveness of trenching to reduce the amount of damage to surface structures from underground mining.

surface structural damage, surface subsidence control, monitoring methods


backfilling, active mines

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longwall, coal mining


Results are presented of a rock mechanics instrumentation program designed to determine surface response due to longwall mining in thick coal at the York Canyon Mine, near Raton, New Mexico.

coal mining, instrumentation, vertical displacement, horizontal displacement, monitoring design, monitoring installation, monitoring equipment, survey methods, survey equipment, survey data processing, rock mechanics, longwall


mine operation, overburden, geologic features


survey design


The use of remote video for abandoned mine investigations and backfill monitoring is a relatively new concept. Information obtained from the video recordings has been useful for determining the location and concentration of drilling necessary for reclamation measures, orientation and condition of pillars and mine passages, extraction ratios, and shaft closure design.

remote sensing, abandoned mines, photography, backfilling, reclamation, coal mining, monitoring equipment, monitoring methods


backfilling


computer, prediction, modeling


surface structural damage, foundations, architecture


Soils in undermined areas experience single or repeated action from rock movements due to underground excavation of useful minerals or construction of different types of underground structures by the covered work method. This paper investigates basic problems in the field of mechanics of undermined soils.

soils, soil mechanics, surface structural damage


foundations, surface structural damage


coal mining, roof support, ground control


hydrology, surface water, subsurface water, coal mining

tunnelling, geologic features


foundations, overburden, coal mining

Knothe, S. Rate of Advance and Ground Deformation. Bergakademie, v. 5, No. 12, 1953, pp. 513-518

(surface subsidence damage, mine design)


(surface subsidence damage, modeling)


Details a method for predicting subsidence caused by underground coal mining by evaluating profile and influence functions.

vertical displacement, prediction theories, profile function, influence function, coal mining


backfilling


This article advocates the adoption of hydraulic backfilling in Britain; the discussion involves a resume of filling techniques in Europe.

backfilling, roof support


Discusses the need for better support systems in mine operations to reduce the number of fatalities due to roof falls and damage to ground surface due to subsidence.

backfilling, mine safety, roof support


The history of hydraulic backfilling was given, with a general resume of the techniques employed in Poland.

backfilling


draw of angle, subsurface water, mine design, time factor


rock mechanics, ground control, coal mining


multiple-seam extraction, mine design, geotechnical


backfilling


ground control, prediction theories


backfilling, hydrology, surface water, surface structural damage, coal mining

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Details the differences between subsidence measured by means of geodetic surveys and subsidence calculated using the Avershin, Budryk-Knothe, and Kochmanski theories of prediction.

vertical displacement, prediction, prediction theories


mine design, ground control, longwall, roof stability, roof support, coal mining


room-and-pillar, ground control, coal mining


longwall, coal mining


In 1978, each individual coal company in the Northern Appalachian Coal Field was contacted for any surface subsidence survey data that they might have. These data could then be assembled to aid subsidence engineering design. After 10 months' survey, the data collected included 17 longwall panels and 2 room-and-pillar sections.

coil mining, survey data processing, survey design, longwall, room-and-pillar, surface structural damage, mine design, vertical displacement, horizontal displacement, time factor


engineering, geologic features


Details a proposed rock-mass-response instrument plan for a longwall mining operation, including descriptions of instrumentation construction plans and practices.

monitoring design, monitoring installation, monitoring equipment, instrumentation, longwall


longwall, roof support, roof stability


coil mining, pillar strength, room-and-pillar, subsurface water, mine design


geologic features, mine design


prediction, modeling


With the advent of total extraction methods on coal mines, the attention has so intensely been focused on what happens when the overburden is relatively soft that there may be a tendency for mining engineers to forget that similar problems can occur even when the overlying measures are strong and competent.

metal mining, overburden, coal mining, roof support, surface structural damage, survey methods

Describes a proposed subsidence prediction theory that would permit the determination of surface deformations for planned underground exploitation.

vertical displacement, horizontal displacement, surface structural damage, mine design, prediction theories, engineering, construction, land-use planning


time factor, prediction theories


A typical longwall mine subsidence survey monitoring grid was installed at the Bureau of Mines. Conventional and high-technology surveying systems were developed over the grid during a 1-month period.

time design, monitoring methods, longwall, monitoring design, photography, survey methods


Examines the influence of the location and sequence of mine workings on the stresses affecting a building.

mine design, surface structural damage


time factor, prediction theories


Deals with the current state of international knowledge on strata and ground movement over mine workings, including detailed descriptions of the damaging effects to mine shafts and the ground surface.

vertial displacement, horizontal displacement, surface structural damage, subsurface structural damage, coal mining


engineering, geologic features, coal mining


fluid extraction


fluid extraction, geologic features


hydrology, subsurface water, oil extraction, fluid extraction


roof stability, seismic, coal mining


mine operation, floor stability


foundations, geotechnical, engineering, modeling
monitoring equipment, modeling, horizontal displacement, vertical displacement, monitoring methods


Describes the results of subsidence investigations over a longwall panel, above which two old workings were present. These results provide a typical example of subsidence behavior in Indian mines.
active mines, abandoned mines, longwall, prediction, multiple-seam extraction


seismic, coal mining, rock mechanics

Describes a method to aid prospecting for and evaluation of non-metallic rocks and minerals. floor stability, roof stability, overburden, geophysical methods

roof stability, floor stability, geophysical methods

Development of longwall systems designs in the U.S. is compared to the European experience. coal mining, longwall, mine design

Problems with longwall mining in the U.S. are discussed, including the effects of shallow workings and roof control.
coal mining, longwall, mine design, geologic features

longwall, shortwall, mine design, ground control, roof support, coal mining

Kuti, J. Longwall Mining in America. Society of Mining Engineers Preprint 78AU336, Sept., 1978. longwall

coal mining

architecture, coal mining, construction, engineering, foundations

construction, architecture, engineering, foundations

architecture, coal mining, foundations


A comprehensive investigation was conducted into geologic features affecting coal mine ground control in western underground coal mines. The study involved a literature search; data on mining operations were collected through interviews with mining and research personnel. Selected mines were toured within 10 coalfields in Utah and Colorado.

literature search, ground control, roof stability, geologic features, coal mining


floor stability, rock mechanics


ground control, soil mechanics


surface subsidence damage


surface subsidence damage, fluid extraction


non-metal mining, environment


Landsberg, H. Recording of Roof Subsidence. Trans. AIME., v. 119, 1936, pp. 139-149.

instrumentation, roof stability


backfilling, anthracite, coal mining


Gives the English mining officials' and technicians' viewpoints at the time (1929) of legal questions regarding subsidence.

ground control, descriptive theories, law


rock mechanics, mine design

Langland, R., D. Fletcher. Predicting Subsidence Over Coal Gasification Sites. UCID-17326, Lawrence Livermore Laboratory, 1976, Livermore, CA.

prediction


backfilling, coal mining


backfilling, coal mining


rock mechanics, geologic features

prediction, survey methods


prediction theories


multiple-seam extraction, longwall


Records a preliminary investigation of effects of faulting on subsidence. Results from a detailed survey indicate the importance of faults.

prediction, survey methods, geologic features


Subsidence is potentially severe in damage to surface utilities and structures, changes in water conditions, and effects on vegetation and animals. To develop prediction methods and models for the United States, more information is needed on magnitude and timing of ground movements and geologic properties.

environment, land-use planning, hydrology, time factor, prediction, modeling, utilities, surface water, subsurface water, geologic features


This paper reviews qualitative and quantitative interrelations among vertical subsidence, geological conditions, and resulting horizontal movements. It includes a case history of horizontal movements occurring over a sulfur mining area.

vertical displacement, horizontal displacement, prediction, finite element method, non-metal mining, geologic features


Reviews cases involving compressible foundations to illustrate the extent of subsidence.

Analytical methods and experimental studies are used to investigate mechanisms of horizontal movement. An earthen dam constructed on a compressible foundation is used as an example of predicted horizontal movements.

horizontal displacement, soil mechanics, prediction, foundations


floor stability, in situ testing


ground control, instrumentation, rock mechanics, in situ testing


engineering, geologic features


Mining operations led to the successful lowering of the Duisberg Harbor and associated industrial facilities. Subsurface geological conditions, planning, and mining operations are outlined, and results described in detail.

hydrology, surface water, subsurface water, coal mining


cal mining, ground control, bumps, roof stability

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Describes in detail the subsidence damage to railroads in the Saar mining region; repair methods used are also detailed.


survey methods


roof stability, ground control, seismic, coal mining, geologic features, mine safety


gologic features, coal mining, surface subsidence damage


remote sensing, coal mining


backfilling, mine waste


surface structural damage, coal mining, abandoned mines


Describes hand stowing in a Spanish copper mine for roof control, due to the limited availability of timber.

backfilling, metal mining, roof support


coal mining, mine operation


construction, engineering

Lindstrom, P. Longwall Mining Results at the Radon Mine. Trans., SME-AIME, Dec., 1964, pp. 397-400.

A thick sandstone layer may have cantilevered over a uranium mine in Utah which was using longwall mining.

metal mining, longwall


Describes a rock mechanics study conducted to monitor deformation of near-seam strata above a longwall panel in the Pittsburgh coalbed. The primary goal was to determine the height of caving immediately behind advancing longwall face supports.

rock mechanics, longwall, overburden, monitoring methods, coal mining


surface structural damage, longwall


foundations, monitoring methods

Design.

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mechanics, stochastic model

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rocks, mechanics, stochastic model

Litwiniszyn,

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presents a series of differential equations to describe subsidence phenomena using the stochastic media approach. Describes and summarizes mathematical and laboratory subsidence models.

prediction, modeling, stochastic model, mathematical modeling

Litwiniszyn,

J.


rock, mechanics, stochastic model

Litwiniszyn,

J.


stochastic model

Litwiniszyn,

J.


stochastic model

Litwiniszyn,


modeling

Litwiniszyn,

J.


Reviews theoretical and experimental investigations carried out in the field of discontinuous media and their application to rock mechanics.

modeling, rock mechanics

Litwiniszyn,

J.

Remark Concerning the So Called "Point of the Attraction Centre" and Its Connection With the Formation of the Subsidence Trough. Arch. Gorn., v. 19, No. 3, 1974, pp. 231-236.

modeling

Litwinowicz,


The effect on communication tunnels of horizontal tensile deformations perpendicular to the tunnel axis has been examined and a generalized hypothesis for vertical and horizontal pressures has been developed.

surface structural damage, vertical displacement, horizontal displacement, subsurface structural damage, utilities


stochastic model


do mining, subsurface subsidence damage, overburden, surface subsidence damage


soil mechanics, floor stability


floor stability


fluid extraction


hydrology, subsurface water, fluid extraction


fluid extraction


fluid extraction, subsurface water


fluid extraction


fluid extraction, surface subsidence damage


fluid extraction


fluid extraction


fluid extraction, prediction


fluid extraction, subsurface water


fluid extraction, monitoring methods


fluid extraction, subsurface water, hydrology


fluid extraction, subsurface water

hydrology


fluid extraction, hydrology


floor stability


hydrology, subsurface water, overburden, ground control


surface water


government, law, land-use planning


non-metal mining


backfilling


insurance, mine operation, surface subsidence damage


Details the derivation of a subsidence prediction theory based upon Coulomb's theory of earth pressure.

vertical displacement, prediction theories


government


coal mining, economics


shortwall, coal mining, mine design, ground control, longwall, roof stability, roof support


coal mining, rock mechanics, monitoring methods, ground control, longwall, instrumentation


prediction theories

Principles of backfilling as applied to underground mines are covered. This report discusses hand, mechanical, and pneumatic backfilling, including compressibility data for materials.

backfilling, literature search, lab testing


Discusses the horizontal and vertical use of borehole cameras.

photography, monitoring equipment


surface structural damage, abandoned mines, coal mining


in situ testing, soils, floor stability


rock mechanics, soil mechanics, geologic features


Approximately 2,540 acres are underlain by underground lead-zinc mines in northeastern Oklahoma. Subsidence problems associated with these mines either existed during mining or have developed since cessation of mining in the Picher Field.

abandoned mines, metal mining, mitigation, historical, surface subsidence damage


prediction, mine design, rock mechanics, instrumentation


Ground elevations above collapsed bord and pillar workings have been measured at seventeen sites. A review of bord and pillar design is followed by a general geological characterization of the superincumbent strata.

room-and-pillar, coal mining, longwall, surface structural damage, pillar extraction, survey methods, vertical displacement, overburden


metal mining, surface subsidence damage


fluid extraction, hydrology


Dry fly ash injection and fly ash-water injection are economical, yet effective methods for remote filling of mine voids to prevent mine subsidence and to control or extinguish abandoned mine fires.

backfilling, abandoned mines, mine fires, mine waste, coal mining


abandoned mines, mine fires, backfilling, coal mining


environment, land-use planning, coal mining

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Coal measures strata become displaced under the influence of mining operations and exert on the roof support, the waste, the coal pillars and the coal faces forces which deform, crack, or break them, since they cannot completely resist the rock movements. The influence of coal extraction reaches as far as the surface and brings about vertical subsidence and horizontal displacement of the ground in that locality.

- mine design, surface subsidence damage, subsurface subsidence damage, mine operation, vertical displacement, horizontal displacement, overburden, roof support, coal mining


- Subsidence data and roof and timber studies were taken from a mine in Pennsylvania.


- coal mining, roof stability, room-and-pillar, utilities, surface subsidence damage, overburden, roof stability


- roads, roof stability, coal mining


- Performance characteristics of an instrumented bolt utilizing the vibrating wire gages were evaluated through 140 field and laboratory tests.


- Coal mining in the Handlová deposit in middle Slovakia takes place under complicated engineering geological conditions at the foot of the volcanic Vtácnik mountains with slopes affected by deep gravitational deformations. Based on a detailed engineering geological investigation after undermining, a prediction was made of the influence of coal mining on the surface of the mountains, with results serving to protect four villages.

- prediction, active mines, surface structural damage, engineering, coal mining, geologic features


- surface structural damage, engineering, roads


- ECOLSITE is an interactive program for computer-aided landform design.

- computer, reclamation, modeling

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- Describes mine flushing using coal mine refuse with a description and cost of one project.
- backfilling, economics, mine waste, anthracite, coal mining


- Further subsidence of a partially constructed building above an abandoned coal mine is prevented by filling the mine with portland cement grout.
- backfilling, surface structural damage, soil mechanics, foundations, abandoned mines, coal mining


- coal mining, mine design, modeling


- coal mining, mine design, modeling


- surface subsidence damage, abandoned mines, coal mining


- surface structural damage, abandoned mines, coal mining


- abandoned mines, surface structural damage, subsurface structural damage, coal mining


- surface structural damage, abandoned mines, room-and-pillar, coal mining


- Provides an understanding of the behavior and potential damage of homes resulting from sag-type mine subsidence. Extensive and numerous case histories in Illinois were collected by the authors. The house response to subsidence-induced ground displacements are summarized and evaluated.

- surface structural damage, foundations, room-and-pillar, abandoned mines, coal mining


- Summarizes and evaluates data on mine subsidence ground movements and associated damages for houses in Illinois. The response of these homes is expressed in terms of repair costs.

- abandoned mines, surface structural damage, economics, coal mining


- Site conditions at several shallow room-and-pillar mines in Illinois are described and compared with the characteristics of the subsidence profiles at the ground surface. This information has been developed in order to improve techniques for evaluating the subsidence potential at sites within the Illinois Coal Basin.

- geotechnical, room-and-pillar, ground control, pillar strength, coal mining


- surface structural damage, coal mining, abandoned mines


- surface structural damage, room-and-pillar, coal mining, abandoned mines

Vast improvement in methods of design and analysis of the long-term stability of overburden above room-and-pillar mines is needed. Improved methods are vital for planning and land development and for prediction above existing, presently stable, room-and-pillar mines. Overburden, room-and-pillar, roof stability, floor stability, pillar strength, mine design, agriculture, coal mining


Presents case histories of subsidence damage occurring over abandoned room-and-pillar mines in Illinois. Major modes of behavior and damage in houses from sag-subsidence are summarized. The houses rested on concrete and masonry foundations. The prevalent mode of failure of bearing walls was inward bending. Failure is analyzed and conventional design procedures are used to evaluate foundation failure.

foundations, surface structural damage, room-and-pillar, coal mining, abandoned mines


The main subsidence-ground-structure interactions and an overview of the response of surface structures to subsidence ground movements are presented. Data presented generally apply to structures up to 2-3 stories high and no more than several hundred feet in length.

surface structural damage, construction, foundations, coal mining


room-and-pillar, abandoned mines, surface structural damage, coal mining


surface structural damage, abandoned mines, coal mining


horizontal displacement, vertical displacement, longwall, surface subsidence damage


Evaluates survey techniques and details the design and construction of survey monuments used to monitor ground movements over longwall mining operations.

monitoring design, monitoring installation, monitoring equipment, survey methods, survey data processing, longwall, instrumentation


Details the application of a general mathematical equation, (derived from a study of subsidence profiles), to two example mining operations. Sections deal with the relation between angle of draw and inclination of strata as well as the accuracy to which subsidence estimates can be applied to local conditions.

vertical displacement, prediction, angle of draw, backfilling, geologic features


Discusses general aspects of subsidence prediction, including data later improved and summarized in the form of the National Coal Board's Subsidence Engineers' Handbook.

prediction, longwall, surface structural damage, vertical displacement, horizontal displacement, National Coal Board, coal mining


surface subsidence damage, coal mining


surface subsidence damage, mine design

Outlines the introduction and initial development of the zone area system in Europe, and the difficulties experienced in applying the system to British mining circumstances.

zone area method, vertical displacement, horizontal displacement, prediction

mine design

fluid extraction

rock mechanics, longwall, modeling

modeling

shortwall, National Coal Board, roof support

mine operation, coal mining

time factor, ground control, modeling

architecture, surface structural damage, engineering

backfilling

rock anchors, reduction of future damage to a residential structure as a result of coal mine subsidence, surface structural damage, coal mining, backfilling, abandoned mines, instrumentation

hydrology, monitoring methods, subsurface water

chimney sinkhole development, map of maximum height chimney subsidence, generalized data on chimney sinkhole movement, abandoned mines, surface subsidence damage, historical, soils, roof stability, floor stability, pillar strength, coal mining

The factors which control chimney subsidence sinkhole development in weak rock were assessed by analyzing the characteristics of approximately 3000 chimney subsidence features along the Colorado Front Range.

abandoned mines, coal mining, geologic features


surface structural damage, engineering


longwall


surface subsidence damage


The advantages of hydraulic flushing over hand stowing are discussed. A brief history and comparison of backfilling practices in the U.S. and Europe is given.

backfilling, coal mining, historical


backfilling, coal mining


This paper describes the use of hydraulic backfilling with room-and-pillar mining.

backfilling, room-and-pillar, metal mining, multiple-seam extraction


The application of hydraulic backfilling to French mining methods is discussed.

historical, backfilling


fluid extraction

- oil extraction, fluid extraction


- roof stability, support, geologic features, coal mining, mine safety


- Discusses the causes and effects of bumps in coal mines.

- bumps, coal mining


- government


- roads


- modeling, mathematical modeling, fluid extraction


- fluid extraction


- economics, land-use planning


- describes an investigation into the behavior of long pillars of potash over time, and their support of the overburden in the Alsace District of France.

- pillar strength, non-metal mining, time factor


- Examines characteristics of subsidence due to longwall mining and resulting damages to surface structures. Includes a general review of subsidence mechanics and protective measures used to minimize damage to surface structures.

- vertical displacement, horizontal displacement, surface structural damage, longwall


- longwall


- This article discusses in detail complete hydraulic filling operations in three mines.

- backfilling, metal mining


- roof stability, ground control, geologic features, coal mining


- roof stability, ground control, geologic features, coal mining


- roof stability, ground control


- roof stability, ground control
backfilling, geologic features, abandoned mines, coal mining

abandoned mines, coal mining, backfilling, geologic features

surface structural damage, surface water, mitigation

details equipment for pumping fine sand, sometimes with cement added, for backfilling active metal mines.
backfilling, active mines, metal mining

ground control

fluid extraction, geologic features

fluid extraction, geologic features

Discuss West Virginia's basic coal mining regulatory programs, including industry profile, evolution of current regulations, administrative issues, and legal issues.
coal mining, law, government, multiple-seam extraction

a description of a coal-refuse reclamation operation with blending and pumping of backfill material to mines is included.
backfilling, mine operation, mine waste, coal mining

subsurface subsidence damage

laboratory experiments were performed on model coal pillars in which the pillars were lubricated at the plate-specimen interface prior to compression tests.
lab testing, coal mining, pillar strength

The strength of a mine roof was tested by injecting air between the roof rock and the overlying layers, and measuring the strain and deflection of the roof until failure.
roof support, roof stability, in situ testing

ground control, instrumentation, in situ testing

in situ testing, foundations

in situ testing, foundations


Milford, K. S. Survey Techniques for the Analysis of Movement. SANGORM Symposium, Oct. 21, 1986, Sandton, South Africa, pp. 7-11. International Society for Rock Mechanics, South African National Group. The requirements for survey networks relating to monitoring projects are outlined. A review is given of some methods currently applied internationally. The problems of invariant quantities and biased estimates are detailed for free net adjustments and the selection of stable points from the geometric stability of the networks as characterized by angles and length ratios is discussed. survey design, survey methods, survey data processing, monitoring methods, instrumentation, modeling, mathematical modeling, stochastic model, geotechnical, computer


Miller, M. J., R. E. Panton, J. R. Steiding. A Comprehensive Program for Dealing With Mine Subsidence Emphasizing Local Government Options. Appalachian Regional Commission Rep. ARC-73-163-2559, 1976, 156 pp. Defines and evaluates potential subsidence risk and mitigation measures within the four anthracite coalfields of northeastern Pennsylvania with an emphasis on an evaluation of surface (e.g. land use) and subsurface (subsidence potential) conditions. insurance, surface structural damage, mine design, surface subsidence control, land-use planning, law, mitigation, anthracite, coal mining, government

fluid extraction

fluid extraction

Details the survey work performed for a subsidence monitoring project. 
monitoring design, monitoring installation, monitoring equipment, survey methods, survey equipment, survey data processing, computer, coal mining

surface subsidence damage

fluid extraction

Discusses the patent of William Griffith: the method of making waste to fill in the gob by blasting down the roof and/or blasting up the floor. 
roof support

Discusses hydraulic injection of culm in 1886 to prevent subsidence of anthracite workings under the city of Shenandoah, Pennsylvania. 
backfilling, anthracite, coal mining

Mill tailings were pneumatically conveyed to, and stowed in, stopes in the South Range of the Copper Range Consolidated Mining Co. 
metal mining, backfilling, mine waste

backfilling, metal mining

backfilling

Describes hydraulic backfilling of a gold mine in South Africa to allow pillar removal. 
backfilling, metal mining, pillar extraction

coal mining, engineering, pillar strength, ground control

A mathematical model utilizes the relative flexural strength of the strata overlying a coal seam to predict the vulnerability of shallow room-and-pillar mined areas to subsidence. The model assumes the failure of the immediate roof as the precursor of a subsidence event. The developed and validated model was subjected to a blind test in an Illinois Coal Basin mine; the model predicted 10 out of 12 subsidence events in the blind half of the study area and two of three additional events in the known half of the study area. 
coal mining, room-and-pillar, prediction, modeling, mathematical modeling, roof stability, abandoned mines

roof bolting, coal mining


This report is a systems approach to problems of an 18-county region in northeastern Pennsylvania, identifying candidate programs for improvement of environmental quality.

land-use planning, environment, coal mining


Refuse removal and subsidence monitoring are the two topics of discussion.

instrumentation, economics, mine waste, monitoring equipment, monitoring design, coal mining


Three different backfill techniques were used to reduce immediate hazards associated with pit subsidence over shallow abandoned coal mines near Hanna, Wyoming. The three techniques were: backfilling with granular soils, a grouted boulder wedge, and open boulder backfilling.

backfilling, abandoned mines, reclamation, historical, mitigation, coal mining


mine design, coal mining, geologic features


roof stability, ground control, shortwall


roof support, roof stability, coal mining


room-and-pillar, coal mining


roof stability, geologic features, coal mining


roof stability, coal mining


The Bureau of Mines monitored surface subsidence, water table levels, and stream flow above a longwall panel in southwestern Pennsylvania, for about 6 months prior to mining and 12 months afterward. Only water levels within the boundary of the longwall showed a precipitous decline as a result of mining.

longwall, hydrology, subsurface water, room-and-pillar, environment, surface water, coal mining


Coal mine roof failure is categorized according to character, trend, or pattern of occurrence. Two principal categories of failure are proposed--geology related and stress related. Each of several subcategories reflects the probable cause of failure and thereby provides a basis for the selection of appropriate techniques for reducing the incidence of failure.

roof stability, mine safety, ground control, overburden, roof support, coal mining, geologic features


ground control


Subsidence insurance claims data and structural monitoring are presented. Also, the changes that have occurred in the Illinois Insurance Code during the first six years the IMSIF has been in existence are described.

- surface structural damage, insurance, coal mining, historical, abandoned mines, monitoring methods, monitoring equipment


- elastic theory, mathematical modeling


- land-use planning, coal mining, abandoned mines


- describes a study performed for a site in Colorado Springs located above abandoned room-and-pillar coal mines last worked in the 1930s and the 1940s. The three phases of the study involved a review of published data on the mines, a limited subsurface investigation, and a very detailed evaluation of the eastern portion of the site resulting in a prediction of final subsidence profile and ground strains.

- abandoned mines, room-and-pillar, prediction, modeling, pillar strength, roof stability, floor stability, overburden, subsurface water, land-use planning, mitigation, backfilling, utilities, literature search, coal mining


- roof stability, floor stability, in situ testing


- modeling, subsurface water


- surface structural damage, construction

- utilities, pipelines, subsurface structural damage


- describes the mechanics of surveying subsidence effects as observed at the ground surface.

- survey methods, National Coal Board, coal mining


- this bulletin is a factual record of experience in partial extraction and is intended to acquaint management with the technique and to serve as a reference for specialists. No attempt is made to discuss the theory of ground movement or to explain the phenomena recorded.

- partial extraction, ground control, National Coal Board, coal mining, active mines


- horizontal displacement, ground control, backfilling, descriptive theories, coal mining

National Coal Board


- mine design, longwall, ground control, prediction, monitoring methods, geologic features, coal mining, National Coal Board


- National Coal Board, abandoned mines, reclamation, coal mining

ground control, mine design, coal mining, National Coal Board


multiple seam extraction, ground control, active mines, National Coal Board, coal mining


coal mining, National Coal Board, active mines, longwall


This handbook presents a systematic discussion of subsidence and subsidence parameters derived from empirical data. It includes a scheme for utilizing these parameters for subsidence prediction in Great Britain.

engineering, prediction, time factor, survey methods, ground control, National Coal Board, coal mining


Details various aspects of subsidence engineering, including prediction methods, subsidence mechanics, and structural precautions against subsidence damage. Prediction, surface structural damage, horizontal displacement, mitigation, engineering, vertical displacement, subsurface structural damage, surface water, surface subsidence control, descriptive theories, ground control, angle of draw, longwall, time factor, National Coal Board, coal mining


National Coal Board, coal mining, surface structural damage


National Coal Board, coal mining, surface structural damage


surface structural damage, National Coal Board, coal mining


mine waste, backfilling, coal mining


Inventories on a county-by-county basis the abandoned underground mine sites in Illinois and an assessment of environmental problems associated with each. Includes mine locations in the appendices.

abandoned mines, environment, reclamation, coal mining


reclamation, mine waste, historical, longwall, coal mining


backfilling


roof support, ground control


longwall, subsurface water, hydrology, rock mechanics
coal mining, surface subsidence damage

floor stability, coal mining

Discusses factors affecting subsidence such as mining methods, type of overburden, and the influence of faults. Describes damage to surface structures; foundation construction to limit subsidence damage is briefly covered.
surface subsidence damage, overburden, surface structural damage, foundations, geologic features


roof stability, geologic features

overburden, surface subsidence damage, coal mining

Effects of subsidence on a concrete-lined air shaft were monitored by surface survey.
Discusses the factors of geologic conditions, mining methods, and survey techniques.
surface subsidence damage, subsurface structural damage, survey methods, geologic features

ground control, coal mining, geologic features

surface subsidence damage, roads

ground control, room-and-pillar, bumps, longwall

room-and-pillar, pillar extraction, coal mining

backfilling

Inundations from saturated soil strata, mine waste, surface water bodies, and flooded mine workings have plagued mining for years. Violent inrushes of saturated soil or mine waste are by far the most hazardous.
overburden, subsurface water, mine waste, surface water

surface structural damage, engineering, subsurface water, hydrology, geotechnical, coal mining, surface water

   surface subsidence damage


   hydrolgy, surface water


   surface subsidence damage


   hydrolgy, coal mining


   photography, remote sensing, instrumentation


   fluid extraction, photography, instrumentation


   This paper is an introduction to the article entitled, "Subsidence From Anthracite Mining," by H. W. Montz. Discusses three problems of surface support and suggests methods which would limit surface subsidence.

   backfilling, mine design, anthracite, coal mining


   surface subsidence damage


   geologic features


   roof stability, roof support, mine safety


   surface subsidence damage


   Discusses bending and fracturing of roof strata, including the influence of the rate of face advance upon the shape and failure of the roof.

   roof stability


   floor stability, hydrology


   mine design, ground control, pillar strength, coal mining


   This paper includes observations of subsidence over steeply sloping seams.

   angle of draw, surface structural damage, coal mining, geologic features

Major applications and specifications of subsidence monitoring systems are reviewed, and the relevant data measurements for a cost-effective monitoring program are identified for each. Seven sets of measurements are formalized as individual measurement systems. Availability, cost, and ease of use are listed for over 100 potentially useful instruments.

monitoring design, monitoring installation, monitoring equipment, survey methods, survey equipment, economics, instrumentation


instrumentation, prediction, monitoring equipment, monitoring design, monitoring methods


instrumentation, longwall, monitoring design, monitoring methods, monitoring equipment, active mines, coal mining


Evaluates construction and monitoring techniques for specific geotechnical instrumentation used to provide overburden and surface-subsidence data. Instrumentation for monitoring ground and subsurface deformations and mine-level stresses are discussed.

monitoring equipment, monitoring methods, monitoring design, survey equipment, geotechnical, longwall, overburden, monitoring installation, instrumentation


Describes results of a project for the design and demonstration of subsidence monitoring systems, including descriptions of the instrumentation systems, the site conditions, problems of installation, resulting recommendations, and subsidence data.

monitoring design, monitoring installation, monitoring equipment, monitoring methods, survey methods, survey equipment


The problems of core recovery in soft or poorly consolidated material are very broad and encompass numerous varieties of conditions and materials.

monitoring installation, overburden, geologic features, geophysical methods


coil mining, prediction

coil mining, monitoring methods, subsidence research


Describes compressibility of fill using data from an experiment at the Kaiser mine in Germany.

backfilling

Presents an in situ method of measuring velocity of sound in rock mine pillars, which was tested in a lead mine. Other testing was performed on concrete pillars.

in situ testing, lab testing, pillar strength, metal mining

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seismic, in situ testing, monitoring methods, monitoring equipment, pillar strength


seismic, subsurface subsidence damage, monitoring methods


rock mechanics, lab testing


modeling, pillar strength, non-metal mining, rock mechanics, lab testing


rock mechanics, roof bolting, mine design, ground control, pillar strength, instrumentation


rock mechanics


mine design, pillar strength, coal mining


mine design


surface structural damage, survey data processing, survey methods, survey design


longwall, mine design, coal mining


This paper describes the undermining of an overland conveyor belt, the measurements of surface subsidence taken and the results obtained. It also describes the effect of subsidence on the conveyor and the preventative measures that could have been taken to prevent the relatively minor
damage that was caused. Though the magnitude of the strains that occurred were very high the
conveyor remained functional and carried coal throughout the undermining.

cell mining, pillar extraction, surface structural damage, monitoring methods, mitigation

Oravecz, K. I. Measurement of Surface Displacements Caused by Extraction of Coal Pillars. Proc.,
Conference on Large Ground Movements and Structures, Cardiff, Wales, July 4-7, 1977. Univ. of

Summarizes the procedures used in a subsidence study conducted over a bord-and-pillar
operation. Details are given on instrumentation used to determine surface subsidence, lateral
displacements, and development and extent of the cave in relation to the mining geometry.

Oravecz, K. I. Analogue Modeling of Stresses and Displacements in Bord and Pillar Workings of Coal

room-and-pillar, modeling, coal mining

Oravecz, K. I. Improved Prediction of Surface Subsidence Using the Influence Function Approach.
Mechanics, South African National Group.

One of the shortcomings of the prediction of surface displacements resulting from caved
tabular excavations at shallow and moderate depths stems from the lack of ability to estimate
precisely the convergence or closure distribution. The development of a variety of numerical
methods assist in the improved modeling of the complex mechanism of caving and the global response
of the rock mass.
prediction, influence function, modeling, computer, finite element method, boundary element

Orchard, R. J. Recent Developments in Predicting the Amplitude of Mining Subsidence. J. Royal

Evaluates the amplitude of mine subsidence through the examination of method of mining,
geological conditions, rate of face advance, time factors, and differing mining conditions. Refers
to the partial subsidence curve, and how this curve can be used for practical applications.
vertical displacement, horizontal displacement, prediction, time factor, geologic features

surface subsidence damage

455-462.

Examines various aspects of mine subsidence: the effects of backfilling on ground movements,
geologic conditions, and an analysis of the relationship among subsidence, seam depth, and
horizontal strain. Tensile strain, compressive strain, and the relationship of strain to slope are
also evaluated.
vertical displacement, horizontal displacement, prediction, backfilling, geologic features

Orchard, R. J. Prediction of the Magnitude of the Surface Movement. Proc., European Congress on
Ground Movement, Leeds, April, 1957.
prediction

The various factors affecting surface movements are summarized and the manner in which they
influence the shape of the subsidence trough is described. Discusses the importance of the width-
depth ratio in determining the maximum amplitude of subsidence. Also included is a brief
discussion of surface damage and methods for reducing this damage.
surface structural damage, mine design, backfilling, survey data processing

Public Health Eng., v. 56, 1957, pp. 188-204.
utilities

Discusses requirements for maximum subsidence and briefly compares pneumatic and hydraulic
backfilling methods. Compares cost of solid backfilling methods with damage produced by
uncontrolled subsidence.
backfilling, economics

Orchard, R. J. Surface Subsidence Resulting From Alternative Treatment of Colliery Goaf. Colliery
Compares surface subsidence caused by both total- and partial-extraction methods when allowing
caving rather than using backfilling. Roadways and packs and their effects upon convergence are
discussed in relation to "effective" panel width and maximum subsidence.
surface structural damage, mine design, backfilling, mine waste, partial extraction, longwall

Orchard, R. J. Partial Extraction and Subsidence. Min. Eng., London, v. 123, No. 43, April, 1964,
pp. 417-430.
Subsidence and roof control are shown to be dependent upon the size of pillars in relation to
the seam depth. With room-and-pillar workings, both safety and higher extraction can be obtained
simultaneously only in shallow seams. With deeper seams, longwall partial extraction layouts are
shown to produce greater mine safety and economical utilization of coal reserves.

partial extraction, roof stability, room-and-pillar, longwall, National Coal Board, mine
safety, mine design, coal mining

Orchard, R. J., W. S. Allen. Ground Curvature Due to Coal Mining. Chartered Surveyor, v. 97, No.
surface subsidence damage, survey methods, coal mining

Orchard, R. J. The Control of Ground Movements in Undersea Workings. Min. Eng., London, v. 128,
Laws governing coal extraction under bodies of water were revised in an attempt by the
National Coal Board to standardize coal extraction legislation and to promote maximum use of
reserves.
hydrology, subsurface water, ground control, National Coal Board, law, coal mining

Suggests an improved method for calculation of maximum subsidence, taking width and depth into
account separately instead of combining them into a width/depth ratio. Examines the mechanics of
harmonious extraction.
longwall, partial extraction, prediction

prediction

Orchard, R. J. Vitrified Clay Pipes in Areas of Mining Subsidence. Clay Pipe Development
Association, 1972.
pipelines, utilities

Orchard, R. J. Some Aspects of Subsidence in the United Kingdom. Paper in Subsidence in Mines, A.
Discusses National Coal Board guidelines for undersea coal extraction.
subsurface water, monitoring design, mine design, National Coal Board, coal mining

261-270.
Discusses the consequences of extracting coal reserves located under bodies of water.
Specific examples detail the results of mining beneath rivers, reservoirs, triassic sandstones, and
aquifers.
surface water, subsurface water, mine design, hydrology, coal mining

Orchard, R. J., W. S. Allen. Time Dependence in Mining Subsidence. Proc., Symposium on Minerals
time factor

Orchard, R. J. Discussion of Kapp, W. A., "A Study of Mine Subsidence at Two Collieries in the
coal mining

Osokin, V. V. Mechanism of Coal Fracture Due to Rapid Relief of External Pressure. Soviet Min.
pillar strength, ground control, coal mining

Osterwald, F. W. Deformation and Stress Distribution Around Coal Mine
rock mechanics, coal mining

Osterwald, F. W. USGS Relates Geologic Structures to Bumps and Deformation in Coal Mine Workings.
Mining Engineering, v. 14, No. 4, 1962, pp. 63-68.
bumps, geologic features

mine operation, mine design, coal mining


Transmission towers, like many other surface structures, are a serious obstruction to total extraction coal mining, and in particular to longwall mining. A 132 kV self-supporting suspension tower was monitored during undermining. The displacements were then used as the input to a computer model of the tower, in an attempt to simulate the effect of differential displacement of its foundation.

modeling, prediction, computer, surface structural damage, foundations, longwall, coal mining, monitoring methods


roof stability, geologic features


Describes an investigation undertaken in the Appalachian coal basin in response to problems of impaired well yields and water quality deterioration.

coal mining, subsurface water, hydrology, longwall, subsurface subsidence damage


non-metal mining, multiple-seam extraction, ground control


Describes the hydraulic sandstowing process, practiced in active mines.

backfilling, coal mining, active mines


surface structural damage, soil mechanics, floor stability


Acoustic-logging methods using a considerable range of wavelengths and frequencies have proven useful in the in situ characterization of deeply buried crystalline rocks. Seismic velocities are useful in investigating the moduli of unfractured rock, and in producing a continuous record of rock quality for comparison with discontinuous intervals of core.

rock mechanics, instrumentation, in situ testing, seismic


backfilling, surface subsidence damage


surface subsidence damage


mine design, ground control, shortwall, roof stability, mine operation


Hydraulic sand backfilling of metal mines in South Africa is used for strata control and increased extraction.

backfilling, metal mining, ground control

coal mining, pillar strength, lab testing

mine design, ground control

lab testing

roof bolting

roof bolting

monitoring equipment, monitoring methods

Describes measurement techniques and equipment appropriate for determining the horizontal and vertical components of displacement and strain, tilt and curvature. Particular attention is given to the principal characteristics and uses of monuments, extensometers, tapes, electronic distance-measuring instruments, theodolite, alignment telescope, spirit level, tilt meter, and borehole inclinometer probe.
monitoring design, monitoring installation, monitoring equipment, monitoring methods, survey methods, survey equipment, ground control, horizontal displacement

mine design, instrumentation, rock mechanics, ground control

roof bolting

in situ testing, rock mechanics, mine design

ground control

surface structural damage, ground control

surface structural damage

Investigates the mechanics of subsidence and methods of reducing surface subsidence damage. Discussions are included on the nature and amplitude of subsidence, subsidence profiles, area of influence, amplitude of strain, time factor, and design of new structures.
vertical displacement, horizontal displacement, surface structural damage, time factor, ground control, architecture

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Pariseau, W. G. Plasticity Theory for Anisotropic Rocks and Soil. 10th U.S. Symposium on Rock Mechanics, University of Texas at Austin, Austin, TX, 1972, pp. 267-296.


Discusses reasons for development of hydraulic backfilling in Britain and indicates major objections and solutions.

economics, backfilling


roof stability, coal mining


coal mining, roof stability, roof support


coal mining, pillar extraction, active mines, mine design


The rib pillars left between adjacent longwall panels are intended to protect the gateroads from harmful stress abutments, with a reduction in pillar width generally requiring an increase in strength of the gateroad support system. Numerical model simulation provides one method of investigating the effect of separate support elements to be evaluated together.

modeling, mine design, longwall, coal mining, pillar strength


Describes hydraulic sand backfilling at a mine in Poland, including methods, costs, and materials used.

backfilling, abandoned mines, economics

Peele, R. Mining Engineers' Handbook. v. 1, 3rd edition, John Wiley & Sons, Inc., New York, 1944. This handbook was written in 1929 and revised in 1941. It is useful as a historical and developmental reference for mining procedures, but is not current enough for modern subsidence control techniques.

historical


ground control, bumps, rock mechanics, lab testing


roof support, ground control, shortwall, coal mining, mine design, active mines


roof bolting, ground control, coal mining


longwall, roof stability, ground control, pillar strength, mine design, coal mining


mine design, ground control, shortwall, rock mechanics, roof stability, coal mining


mine design, ground control, longwall, shortwall, roof support, roof stability


roof support, shortwall, coal mining


roof support, mine design, ground control, roof bolting

Classifies and discusses two ground movement theories: descriptive theories and continuum mechanics theories. Analyzes subsidence through determination including descriptions of profiles, strains, profile slopes, and profile curvatures.

vertical displacement, horizontal displacement, surface structural damage, mine design, monitoring design, survey methods, survey equipment, prediction, descriptive theories, continuum mechanics theories, coal mining, prediction theories, ground control


pillar strength, coal mining


roof stability, mine design


Presents a case history of surface subsidence over a longwall section at an eastern Ohio mine, including surface monitoring plans, measured results, and subsequent surface structural damages. surface structural damage, monitoring design, survey design, mine operation, longwall, coal mining


multiple-seam extraction, coal mining


surface subsidence damage, environment, coal mining, land-use planning


cracking, coal mining, longwall, modeling


longwall, coal mining, rock mechanics, modeling


Contains background information on subsidence engineering; with reference to subsidence-related structural damage and damage prevention techniques. An empirical subsidence prediction method is discussed.

vertical displacement, surface structural damage, prediction, coal mining


room-and-pillar, surface structural damage, coal mining


This paper is a summary document of five previously published papers on subsidence over 24 longwall panels and 5 room-and-pillar sections in the northern Appalachian coalfield. It includes the physical characteristics of 54 surface subsidence profiles collected for longwall and room-and-pillar mining. Empirical and analytical methods of prediction and modeling are discussed in detail.

vertical displacement, surface structural damage, longwall, room-and-pillar, prediction, modeling


cracking, coal mining, roof stability, longwall, modeling


vertical displacement, horizontal displacement, longwall, prediction, ground control, angle of draw, geologic features, coal mining

Peng, S. S., H. S. Chiang. Longwall Ground Control—U.S. Experiences. Journal of Mines, Metals, and Fuels, Sept., 1983, Special Number on Update on Longwall Mining—Evolving Trends, pp. 397-415. Longwall mining in the U.S. for over a decade has demonstrated that it is safe and complies easily with current laws, and that it is highly productive provided it is properly designed and operated.

longwall, roof support, roof stability, mine design


Peng, S. S. Case Studies Illustrate the Need for a New Concept of Coal Pillar Design. Mining Engineering, v. 38, No. 11, Nov., 1986, pp. 1033-1035. The most commonly used ground control design in coal mining is the determination of pillar size by various pillar strength formulae for mine layout. However, there have been few documented case histories concerning the validity of those strength formulae. pillar strength, room-and-pillar, mine design, roof support, finite element method, coal mining


Penman, O. Hydraulic Stowing in Thick Seams of India. Trans., Institution of Mining Engineers, v. 80, 1930-31, p. 123. Hydraulic backfilling in India where many seams are over 20 ft. thick and range up to 90 ft. in thickness is described. backfilling, pillar extraction, room-and-pillar

  government, anthracite, coal mining, law

  law, coal mining, government

  land-use planning, coal mining

  law, anthracite, coal mining, surface subsidence damage

  law, coal mining, government

  surface structural damage, law, coal mining, mine operation, mine design

  government, law, coal mining

  With development of the Rocky Mountain region, damage to buildings due to mine subsidence has increased dramatically. Much of the damage reported could be avoided by prudent planning and zoning practices. Where zoning doesn't keep building away from mine subsidence areas, other measures have to be employed to avert or mitigate potential subsidence damage.
  surface structural damage, abandoned mines, geotechnical, mitigation, architecture, construction, foundations, utilities, coal mining

  Describes a subsidence prediction method that uses mathematical relationships to model the formation of subsidence troughs above mine workings, taking into account the properties of overlying strata, vertical displacement, horizontal displacement, prediction, mathematical modeling, modeling, geologic features

  mathematical modeling, modeling

  coal mining

  surface subsidence damage, coal mining

  coal mining

  The development of the new town of Peterlee in northeast England provides an instance of successful coordination of surface building and underground coal mining.
  multiple-seam extraction, land-use planning, surface structural damage, construction, National Coal Board, coal mining, architecture

Coal mining, monitoring equipment, abandoned mines


Fluid extraction


Full-scale model testing of a simplified mine entry with roof-bolt support as well as computer modeling of a layered mine roof with slip planes pierced by roof bolts was accomplished by the U.S. Bureau of Mines. Excellent correlation was obtained between physical model results and computer modeling results.

modeling, geotechnical, computer, finite element method, mine design, roof stability, coal mining, roof bolting, active mines


Consists of the abstract of a paper which describes pressure grouting of an undermined site.

to surface structural damage, backfilling


The concept of cyclic sedimentation is related to common problems encountered in foundation investigations in coal sequences. Discusses remedial measures required over undermined areas.

engineering, foundations, mitigation, coal mining


Gives results of laboratory strength tests on different types of coal measure rocks; includes a description of the nature of fractures which form in the roof.

Pillar strength, angle of draw, time factor, modeling, coal mining, overburden, lab testing, geologic features


Discusses results of observations ahead of and behind a longwall face at a depth of 900 yards.

A seam 250 yards above the longwall face was monitored for subsidence effects.

subsurface subsidence damage, multiple-seam extraction, longwall


Surface subsidence damage, subsurface subsidence damage


Discusses roof and roadway maintenance pertaining to ground control in Great Britain.

Discusses strain distribution near roadways and methods for measuring strain and loading.

ground control, roof support, mine operation, monitoring methods, subsidence research


mine design, coal mining


Evaluation of subsidence potential over the Pikeview Coal Mine sloping entryway in Colorado Springs, Colorado indicated a substantial risk of future ground movements. A procedure was formulated to block the lower end of the entryway and backfill the upslope portion of the opening with cement slurry.

abandoned mines, backfilling, historical, reclamation, coal mining


Prediction


Two-stage extraction room-and-pillar mining of potash was found to increase pressure on the extraction face; the solution was to reduce the extraction rate, resulting in yielding pillars, rather than caving. Increased extraction resulted since no pillars were completely abandoned as a result of unstable roof conditions.

longwall, non-metal mining, room-and-pillar, pillar extraction, pillar strength, yielding supports


surface subsidence damage, coal mining


abandoned mines


roof stability, ground control, mine design, geologic features


survey design, monitoring design


cal mining, active mines


floor stability


computer, ground control


construction, modeling


fluid extraction


Describes subsidence in 6 areas of California caused by development of groundwater resources; suggests mitigation or elimination procedures for the problem.

subsurface water, fluid extraction


fluid extraction, hydrology


fluid extraction

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fluid extraction

fluid extraction, subsidence research

fluid extraction

fluid extraction

fluid extraction, hydrology

fluid extraction

fluid extraction, hydrology

fluid extraction

surface subsidence damage, fluid extraction

fluid extraction

monitoring equipment, seismic

Discusses several pneumatic backfilling systems used in Germany; advocates their use in Britain.
backfilling, surface structural damage, surface water

backfilling

surface subsidence damage, coal mining

finite element method, modeling

surface subsidence damage, coal mining

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subsurface subsidence damage, surface subsidence damage


surface subsidence damage


describes trends in ground control and rock mechanics, especially with the use of rapidly advancing faces in longwall mining. The growth of rock mechanics research is of primary importance to the mining engineer.

ground control, rock mechanics, mine design, mine operation, longwall


environment


rock mechanics, ground control, soil mechanics


longwall, coal mining


longwall, coal mining


longwall, coal mining


longwall, coal mining


longwall, coal mining


subidence research, coal mining


The Bureau of Mines, in cooperation with the Illinois Mine Subsidence Insurance Fund, is monitoring the response of two foundations to ground movements induced by subsidence from high extraction mining in southern Illinois.

insurance, foundations, monitoring methods, monitoring equipment, vertical displacement, survey methods, coal mining


Subsidence problems in a karst area were aggravated by groundwater withdrawal from deep wells. fluid extraction, subsurface water, geologic features, land-use planning, hydrology


oil extraction


non-metal mining, Finite element method, oil extraction, modeling


  rock mechanics, coal mining, lab testing

  roof support, roof stability, coal mining, mine operation

  backfilling, mine fires

  Discusses the construction of concrete rafts to carry steel structures for overhead electrification.
  railways, foundations, utilities

  backfilling

  Describes methods of transporting sand in India from riverbanks to mines for backfilling.
  backfilling

  mine design, environment, modeling, coal mining

  longwall, environment, mine design, shortwall, surface subsidence damage, coal mining

  longwall, coal mining, geologic features

  roof stability

  Describes the use of urethane rubber in the construction of a layered model simulating strata over mine workings. This model is compared to subsidence profiles observed for some European mining.
  elastic theory, modeling, angle of draw, prediction

  modeling, rock mechanics

  engineering

  finite element method, modeling, computer

  modeling

  Survey lines were established parallel and perpendicular to the line of pillar extraction in an attempt to determine the shape of the traveling subsidence trough.
  pillar extraction, angle of draw, survey design, survey methods, coal mining

  Stamps sands were used for backfilling and for subsidence prevention.
  backfilling, metal mining, ground control

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mine operation, historical

rock mechanics, mine design

Reed, J. J. Case History in Pillar Recovery. Trans., AIME (Mining Engineering), v. 11, July, 1959, pp. 701-705.
rock mechanics, pillar extraction

rock mechanics, pillar strength, roof support

roof support, rock mechanics

Describes subsidence observations in the anthracite area, where one seam is worked at a moderate depth, the floor is hard and no heaving takes place, and the coal serves as a true boundary because of its resistant nature.

anthracite, coal mining, roof support, floor stability, angle of draw

This paper discusses coal as a legitimate crop in terms of a long-term land-use program. It also describes grassland farming as a viable alternative to cornland, concluding that corn, coal, and cattle are still compatible.
agriculture, reclamation, land-use planning, coal mining

This paper analyzes partial-extraction methods that can be used to minimize subsidence damage to railway lines, with discussions on the use of safety pillars and various mine designs. A short explanation of the mechanics of ground deformations is also given.
mine design, railways, partial extraction, room-and-pillar, pillar strength

Pertains to the behavior of strata overlying mined-out areas and the calculation of surface movements. Briefly mentions the use of empirical data to predict subsidence.
rock mechanics, overburden

modeling

Reppert, A. E. Pillar Falls and the Economic Recovery of Coal from Pillars. Proc., West Virginia Coal Mining Institute, 1911.
room-and-pillar, economics, pillar strength, pillar extraction, coal mining

Research Committee of Midland County Institute of Mining Engineers. The Influence of Variation in the Nether Roof on the Incidence of Falls. Trans., Inst. of Mining Engineers, v. 84, 1932-33, pp. 93-110; v. 85, 1932-33, p. 27.
Describes a series of studies made in a mine seam which in different areas has a roof composed of sandstone, stone bind, shale, clod, and coal.
roof stability, coal mining, geologic features

monitoring methods, multiple-seam extraction, monitoring equipment, modeling, in situ testing, coal mining

floor stability, coal mining, in situ testing

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A brick-lined railway tunnel was successfully undermined, by a 5 ft. thick seam of coal lying 613-701 ft. below the tunnel floor. The tunnel required only minor repairs after mining.

railways, backfilling, coal mining


Discusses reasons why hydraulic backfilling would not be applicable in Illinois for subsidence prevention. These reasons include insufficient mine waste, inaccessible surface material due to extensive farming, and soft underlay which is sensitive to mine water.

backfilling, floor stability, mine waste, agriculture, coal mining


angle of draw


Tests of coal pillar strength and other roof supports were reviewed.

roof support, anthracite, pillar strength, ground control, mine design, coal mining, lab testing, in situ testing


roof stability, roof support, pillar strength, coal mining


surface subsidence damage, metal mining


ground control, room-and-pillar, mine design, bumps, coal mining


ground control, room-and-pillar, floor stability, mine design, bumps, coal mining


The author reviewed work by P. Bucky, Helmut Landsberg, and Ryojun College, on the strength and elastic recovery of rocks.

mine design, pillar strength, room-and-pillar


coal mining, metal mining, non-metal mining


Reviews subsidence studies in the gold fields of India, as well as those by the U.S. Bureau of Mines at the Montour mine in Pittsburgh.

metal mining, coal mining


Describes hydraulic, pneumatic, and mechanical backfilling; also deals with many aspects of European mining including filling problems and procedures.

environment, mine operation, law, backfilling, geologic features


This article reviewed subsidence investigations in 1939.

backfilling


This article discusses increased efficiency and lowered cost involved using recycled mine waste as fill in a Cuban copper mine.


floor stability, pillar strength, coal mining

coil mining, floor stability, pillar strength

coil mining, surface water, surface structural damage

floor stability, pillar strength, room-and-pillar, ground control, coal mining

floor stability, coal mining

summarizes the history of subsidence prediction, current practices in subsidence engineering, and recent developments of predictive subsidence models. The discussions include analytical approaches for longwall and room-and-pillar mining techniques, prediction, prediction theories, coal mining, modeling, influence function, National Coal Board, profile function, historical, room-and-pillar, longwall

roof stability, coal mining

fluid extraction, subsurface water, hydrology, subsurface subsidence damage

longwall

longwall, shortwall

Describes hydraulic flushing techniques used in the Homestake Gold Mine, South Dakota. 
metal mining, backfilling

Underground mining of coal by longwall mining methods has not been a predominant technique in Ohio. To date, only five mines in the state utilize this method, however, the technique has sparked a certain amount of controversy. 
law, longwall, government, subsurface water, surface water, coal mining

Ruppeneit, K. W. Pressure and Deformation of Rocks in Flat Lying Seams. Moscow, USSR, 1957. 
rock mechanics

pillar strength, mine design, rock mechanics
Examples
14,
Elastic I. linear partially of vertically
Practical
reinforce,
1964, methods occurs at the case
Reef Underground Salamon, Ph.D.
elastic theory
roof stability
A non-linear distribution of vertical displacement versus aquifer depth is calculated in the case of a partially penetrating well. For a fully penetrating well, however, a linear distribution is observed. The solution exhibits a vertically uniform horizontal displacement in the case of a fully penetrating well and, for a partially penetrating well, the maximum horizontal displacement occurs at the elevation of the well bottom.
vertical displacement, horizontal displacement, subsurface water, hydrology, finite element method, fluid extraction
mine design, ground control
elastic theory, modeling
elastic theory, surface structural damage, room-and-pillar, pillar strength
elastic theory, continuum mechanics theories, modeling, influence function
Discusses fundamental principles and basic solutions derived from idealized models, practical methods of determining subsidence parameters from a given mining geometry, application of elastic theory, and protection of surface installations by underground pillars.
rock mechanics, ground control, surface subsidence damage, modeling, elastic theory, pillar strength
Field experiments were performed in order to establish the behavior of coal measure strata, including displacement patterns, when these strata are subjected to mining conditions.

room-and-pillar, overburden, coal mining


pillar strength, coal mining

Salamon, M. D. G. A Method of Designing Bord and Pillar Workings. Journal of the South African Institute of Mining and Metallurgy, v. 68, Sept., 1967, pp. 68-78. Formulates a procedure to determine mining dimension in bord and pillar workings, using a pillar strength formula which was devised statistically from surveys of mines in South Africa. This formula assumes that the entire weight of the overburden is carried by the pillars.

room-and-pillar, pillar strength, mine design, overburden


rock mechanics


rock mechanics, longwall


pillar strength, ground control, rock mechanics, coal mining


Gives a brief summary of the principles involved in treating tabular excavations as displacement discontinuities, the outlines of which coincide with the plan of the excavations. More details are given on the application of these principles to the prediction of displacements at the ground surface and to the protection of structures on the surface.

vertical displacement, horizontal displacement, mine design, prediction, modeling, surface structural damage


rock mechanics


backfilling, coal mining


backfilling


finite element method, modeling


prediction, modeling


prediction, subsidence research


coal mining, metal mining, non-metal mining, rock mechanics, law, surface structural damage, monitoring methods, survey methods, room-and-pillar, longwall, influence function, computer, modeling, prediction, subsurface water, mine design
Sann, B. Considerations on Precalculating Ground Subsidence Due to Coal Mining. Bergbau-Rundschau, 1949, pp. 163-168 (in German).
prediction, coal mining

Sattoriva, G. Computer-Aided Reclamation Planning. Session paper, American Mining Congress 1982
Coal Convention, St. Louis, MO, May 9-12, 1982.
coal mining, reclamation, computer

fluid extraction, geophysical methods

prediction

backfilling, multiple-seam extraction, coal mining

Details a model in which a subsiding region is modeled as an infinitely long elastic layer resting on a rigid base and deforming under its own weight into an opening at its lower edge. An approximate solution for vertical displacements on the ground surface and over the opening is found for the case when the layer thickness is much greater than the width of the opening.
modeling, vertical displacement, geologic features

Quantitatively discusses a method of modeling subsidence over an underground cavity; assumes the subsiding region to be an infinitely long elastic layer that rests on a rigid base and deforms under its own weight into an opening under its lower surface. An approximate analytic solution based on Fourier transform methods is found for vertical displacements of the ground surface and the roof of the opening when the layer thickness is much greater than the width of the opening. 
vertical displacement, modeling, geologic features

surface subsidence damage

Describes hydraulic flushing procedures.
backfilling

ground control, longwall, roof stability

room-and-pillar, coal mining, overburden

Describes systematic subsidence behavior investigations in Indian coalfields which began in 1964.
prediction, surface subsidence damage, mine design, multiple-seam extraction, room-and-pillar, longwall, surface structural damage, surface water, coal mining, overburden

prediction, survey methods, monitoring methods

prediction theories


prediction theories

pillar strength, longwall, coal mining


rock mechanics


A detailed subsidence and strain monitoring program was initiated above a number of active mines, located in three major coal-producing counties of Virginia. The aim of this program was to enhance the data base with accurate and complete measurements of surface movements and to allow, therefore, the evaluation and refinement of prediction techniques.
prediction theories, prediction, horizontal displacement, coal mining, law, government, profile function, influence function, monitoring methods, survey equipment, survey methods


Reviews the design and installation of an automatic data-acquisition system over a coal mine in Illinois to monitor and record ground deformations associated with underground mining operations.

monitoring design, monitoring installation, monitoring equipment, survey equipment, computer, coal mining


Compares and describes the longwall mining methods and equipment of the time (1963).
coal mining, longwall, roof support, mine operation

prediction, soil mechanics

prediction, tunnelling


subsurface water, coal mining, geologic features

fluid extraction, soils

overburden, coal mining


longwall, modeling


Various measurements were made to determine the effectiveness of backfilling methods, as well as to determine the effect of subsidence on roof strata.
backfilling, subsurface subsidence damage, overburden, roof stability


to backfilling, mine waste

Schwert, B. Friction Rock Stabilizers--A New Rock Reinforcement Method. Presented at 1977 SME-


roof support, ground control


prediction


backfilling


overburden, coal mining


crushing, overburden, soil mechanics


The Stress Control Method of mine design provides enhanced engineering control over the behavior of underground workings in comparison to conventional mine design methods. A field example is given in this paper to illustrate the application of this Method.

finite element method, mine design, computer, modeling, prediction


ground control


Discusses three factors pertaining to surface development and exploitation in undermined areas: orthodox ground movements related to the dimensions of mineral extraction, geotechnical conditions, and the tolerance of surface structures to ground movements.
mine design, mine operation, surface structural damage, mitigation, coal mining, land-use planning, geologic features


Examines methods of subsidence prediction and engineering and their influence by local geological site conditions. Describes current forms of instrumentation and field measurement techniques.

prediction, survey methods, instrumentation, geologic features


surface structural damage, engineering


Discusses various subsidence parameters and their effects as they relate to mine extraction dimensions; explains various means of reducing subsidence damage. Also included is a historical review of the theories and work by early subsidence investigators.

vertical displacement, horizontal displacement, surface structural damage, subsurface structural damage, survey data processing, engineering, historical, prediction theories


surface subsidence damage


prediction, coal mining


fluid extraction, geologic features


Model sandstone pillars were used in laboratory compression tests. The concluding theory was that average width rather than least width is important in determining pillar strength.

room-and-pillar, pillar extraction, pillar strength, rock mechanics, partial extraction, lab testing


ground control, instrumentation, roof stability


mine design, ground control, longwall, roof stability


Many theoretical methods are available to estimate subsidence-induced horizontal ground strains. However, no evidence exists as to the magnitude of ground strains developed from collapse or the type and amount of structural damage that can be expected. To quantify the above questions, the author conducted an investigation of structures that are underlain by mine workings, but were built prior to mining.

abandoned mines, surface structural damage, horizontal displacement, foundations, prediction, influence function, coal mining, architecture


floor stability, longwall

mine design, mine operation, longwall


longwall, modelling

Shoemaker, F. D. How and Why Backfill Anthracite Mines. Coal Age, v. 44, May, 1939, p. 68. A 4.5 ft. seam was successfully extracted beneath an industrial and residential district. anthracite, backfilling, room-and-pillar, coal mining, economics


mine operation

Shoemaker, R. P., T. J. Thorley. Problems of Ground Subsidence. Journal of the American Water Works Assoc., v. 47, Apr., 1955, pp. 412-418. Subsidence problems associated with oil extraction from the Wilmington oil field in Long Beach, CA are discussed. Repressurization using gas or water as a means of arresting subsidence is briefly mentioned.

oil extraction


roof support, ground control


ground control, active mines


surface structural damage, engineering

Sinclair, D., P. B. Bucky. Photoelasticity and its Applications to Mine Pillar and Tunnel Problems. Trans., Amer. Inst. Min. and Metal. Engineers, v. 139, 1940, pp. 224-252. Isotropic transparent material was stressed and viewed with polarized light, obtaining an image which indicates the magnitude of the stress in color bands of light. This method studies the principal points of maximum stresses in loaded model pillars; it includes the effects of cutting the tops of the pillars or of tunnelling underneath them.

pillar strength, modeling, tunnelling


survey design, survey methods, coal mining


Discusses methods of roof support for safe and economical extraction of coal: includes ways of reducing subsidence damage both underground and on the surface.

ground control, roof support, economics, construction, engineering, mine design, backfilling, coal mining


floor stability


This paper details methods and equipment used in pneumatic filling, and describes various problems involved; also mentions potential explosion hazards.

backfilling, coal mining


Lists states in the U.S. with subsidence damage and suggests a dual approach to attack the problem of subsidence.

- surface subsidence damage, subsurface subsidence damage, environment, prediction
- backfilling, coal mining


This paper attempts to establish relationships of various levels of subsidence damage for aquifers, agricultural lands and other renewable resource areas.

- hydrology, agricultural, environment, land-use planning, surface subsidence damage, subsurface water, surface water, coal mining


The Surface Mining Control and Reclamation Act of 1977 (SMCRA) requires underground coal mine operations to prevent "material damage" to renewable resource lands caused by subsidence. However, what constitutes material damage is not defined. This paper discusses the applicable criteria for agricultural lands, forests and grazing lands, surface water bodies, and ground water aquifers. Although data on the subject are limited, an attempt is made to present quantitative guidelines to distinguish between moderate and severe damage due to subsidence.

- law, surface subsidence damage, surface water, subsurface water, hydrology, agriculture, environment, land-use planning, coal mining


- subsurface water, prediction, modeling


- partial extraction, surface subsidence damage


Analyzes the effect of different natural and operational factors on the magnitude of the angle of draw in mine subsidence with reference to the mechanism of draw. Also discusses the importance of angle of draw in measuring methods.

- vertical displacement, horizontal displacement, backfilling, angle of draw


Subsidence mechanics are briefly outlined, followed by a discussion on the economic aspects of packing. Various packing parameters are defined, including: compressibility, consolidation, cementation, packing efficiency, and pack density. The results of previous research are summarized for each parameter; includes useful information on the angle of draw.

- backfilling, economics, angle of draw


A numerical procedure based on the nonlinear finite element analysis has been developed for the prediction of subsidence profiles over longwall mine panels. The behavior of the overburden rock was modelled by using an elasto-plastic constitutive model.

finite element method, modeling, prediction, longwall, elastic theory, overburden


A procedure based on the nonlinear finite element analysis was investigated for the prediction of subsidence caused by longwall mining. This paper presents a case study involving predictions of subsidence at a coal mine panel for which a considerable amount of data was available in the literature. Some aspects of the selection of material properties and the shape of the subsidence profile are discussed.

finite element method, prediction, longwall, modeling, coal mining


Presents two approaches based on the finite element method for modelling the behavior of overburden rock masses over longwall mine panels for predicting surface subsidence.

finite element method, prediction, longwall, modeling, continuum mechanics theories, subsidence


Analyzes specific problems related to mining discontinuous seams with variations in seam height; indicates that low density supports are needed to operate under thick sandstone roofs.

finite element method, modeling, prediction, longwall, computer, subsidence


finite element method, modeling, prediction, longwall, subsidence


finite element method, modeling, prediction, coal mining, subsidence


finite element method, modeling, prediction, longwall, subsidence


finite element method, modeling, prediction, longwall, subsidence


finite element method, modeling, prediction, longwall, subsidence


finite element method, modeling, prediction, longwall, subsidence


mine design, mine operation, ground control


Examines the geologic and mining conditions and subsidence problems of 12 coal mines located in the Appalachian Region, the Illinois Basin, and the Rocky Mountain Region. Remarks and suggestions concerning subsidence prediction and control are made on the basis of the mines inspected.

vertical displacement, horizontal displacement, subsurface water, mine design, prediction, surface subsidence control, coal mining, geologic features


subsurface water, hydrology


fluid extraction


ground control


subsidence research


Outlines methods of sampling and characterizing coal mine overburden to aid mining and reclamation plans.

reclamation, overburden, coal mining, monitoring installation, mine design


backfilling


pillar strength, monitoring equipment, monitoring methods, room-and-pillar, longwall, in situ testing


historical, coal mining


rock mechanics, pillar strength, mine design, lab testing, coal mining


mine operation, coal mining, active mines


mine design, mine operation, longwall
coal mining, surface water, subsurface water

engineering, construction, surface structural damage, abandoned mines

Describes the use of pneumatic backfilling as an alternative to hand packing for roof control in longwall coal mines.
backfilling, longwall, coal mining, roof support

Designed for Illinois community officials to detail the characteristics of subsidence. Examines a series of options available to local government to deal with subsidence, including the Illinois Mine Subsidence Insurance Fund, a subsidence preparedness plan, public facility construction policies, land development ordinances, and underground mine permit processes.
vertical displacement, horizontal displacement, law, land-use planning, government, insurance, construction, mine operation, land values


Describes instruments and methods used to measure strata movements and pillar contraction when mining superimposed coal seams which are 60-170 ft. below the surface.
monitoring equipment, monitoring methods, multiple-seam extraction, coal mining, pillar strength

ground control, metal mining

subsurface structural damage, soil mechanics, engineering

Describes grout case and caissons to support structures over mined and subsidence prone areas; includes costs for methods employed.
engineering, construction, economics, roof support

coal mining

floor stability, geologic features, coal mining

floor stability, ground control, geotechnical, coal mining, geologic features

Discusses the design and installation of surface, subsurface, and mine-level instrumentation to monitor ground movements associated with pillar-extraction mining.
monitoring design, monitoring installation, monitoring equipment, instrumentation, room-and-pillar, pillar extraction


This bulletin discusses the reinforcement of small mine workings with timber.

This bulletin discusses the reinforcement of small mine workings with timber.

This bulletin discusses the reinforcement of small mine workings with timber.

Computer programs are used to solve structural problems found in determining stress on pillars of various sizes.

pillar strength, computer, mine design


Pillar stability is presented in a computer model as the interaction between the pillars and the surrounding rock. Qualitative behavior of pillars is obtained using compression tests.

pillar strength, computer, room-and-pillar, modeling, rock mechanics, lab testing


Describes a digital computer method for computing stresses and displacements due to a dislocation in an otherwise continuous linearly elastic, infinite rock mass.

rock mechanics, elastic theory, computer, modeling


government, law


room-and-pillar, pillar extraction


roof stability, seismic, coal mining


Discusses the importance of planning the behavior of main roadways of a mine; shows the harmful effect of a pillar of abandoned coal in a seam on roadways situated in this pillar or immediately above or below it.

design, pillar strength, coal mining


roof support, roof stability, coal mining


roof stability, coal mining


This article reviews and compares various formulas for calculating the size of a shaft pillar. bumps, overburden, angle of draw, room-and-pillar, roof stability, pillar strength


coal mining


law, coal mining, government, mine operation


Discusses pressure exerted on pillars and various means of estimating this pressure and the strength of coal within the pillars.

coal mining, pillar strength


Describes the use of an empirical subsidence prediction method applied to Saskatchewan potash mines. Data collected from five producing mines indicated that subsidence tends to be time dependent, and occurs in two stages.

modeling, prediction, time factor, zone area method, influence function, computer, non-metal mining, active mines

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backfilling


roof bolting


This bulletin discusses mine methods which provide for the support of overlying strata.

backfilling, multiple-seam extraction, pillar strength, room-and-piller, mine design, mine operation, coal mining, overburden, roof stability


fluid extraction, soils


prediction, mine design, surface structural damage, coal mining


prediction, surface subsidence damage, coal mining


roof stability, roof support, mine design


backfilling


backfilling


mine design, ground control


Describes physical requirements for hydraulic fill material in metal mines.

backfilling, economics, metal mining, historical


Various characteristics of hydraulic fill slurries are discussed, including viscosity, percolation rates, friction losses, percent solids by weight and by volume, and critical velocity.

backfilling


instrumentation, monitoring methods


coil mining, floor stability


coil mining


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computer, multiple-seam extraction, modeling, coal mining

Contains mine layouts and methods for mine operations.
mine design

backfilling, longwall, roof support

Discusses history of hydraulic flushing in German mines.
backfilling, historical

fluid extraction

surface structural damage

Discusses several applications and procedures for using fly ash to minimize mine subsidence damage.
backfilling, abandoned mines, coal mining

Stutzer, O. Geology of Coal. The University of Chicago Press, Chicago, IL, original 1923, translation 1940.
floor stability, coal mining, geologic features

longwall, subsurface subsidence damage

roof stability

Sugawara, K., Y. Obara, H. Okamura. Pre-Calculation of Surface Subsidence Due to Coal Mining. Proc., 5th International Conf. on Numerical Methods in Geomechanics, Nagoya, Japan, April 1-5, 1985.
A finite element procedure is applied for the prediction of surface subsidence. It features improvements, such as use of joint elements for bedding planes and considerations of the scale effect on the stiffness of discontinuity and the transverse anisotropic behavior of rock related to the tensile fracture, and permits the simulation of thin seam extraction.
prediction, finite element method, longwall, overburden, modeling, coal mining, geologic features

photography, coal mining, roof stability

environment, coal mining, land-use planning

rock mechanics

modeling


Highlights the results of the subsidence research program at Sandia National Laboratories: the application of empirical methods to the subsidence above longwall panels; the use of the "rubble model" to describe the behavior of broken strata as it distends when it falls to the mine floor and then is subsequently compacted by overlying strata; and the application of physical modeling techniques (centrifuge simulations) and numerical techniques to study the failure mechanisms in highly structured stratigraphy.

vertical displacement, longwall, prediction, modeling, geologic features, subsidence research


influence function, prediction, rock mechanics


modeling, coal mining


modeling, coal mining


modeling, mine design


prediction, coal mining


Details the use of complementary influence functions in describing surface subsidence caused by high-extraction mining.

vertical displacement, prediction, influence function


rock mechanics, modeling


prediction, influence function, rock mechanics


coal mining, modeling


prediction, modeling, overburden, coal mining, roof stability


prediction


The program objective was to develop the capability to predict surface subsidence above coal mines as a function of the mine plan and the geologic setting. The scope was expanded to encompass strata movement associated with in situ extraction of fossil fuels.

prediction, coal mining, mine design, geologic features, longwall, modeling, roof stability, room-and-pillar, influence function, finite element method


longwall, coal mining


Describes a building construction system (CLASP) designed for articulated structures located over undermined areas. Rather than depending on strength, the buildings are designed to depend on lightness and flexibility to withstand the effects of subsidence. The key component, the diagonal spring-loaded wind brace, permits the buildings to resist wind forces but compress to allow the building frame to adjust to subsidence.

surface structural damage, surface subsidence control, construction, engineering, architecture


caving the roof in certain areas lessened the stress and strengthened the roof over areas adjacent to the caved area.

roof stability


pillar extraction, room-and-pillar


Experiments using sand and glass spheres as media investigated the small subsidence of media between two parallel plates of glass resulting from the medium escaping through a narrow opening at the lower edges of the plates.

prediction, stochastic model, modeling


A stochastic model for predicting subsidence of a granular medium is presented; it yields a Markov chain for which a solution is not found. Time is eliminated as a variable by examining the subsidence only after motion has ceased.

prediction, stochastic model, modeling


Covers subsidence of mines operated prior to 1900 at depths of less than 100 ft. Possible subsidence prevention measures include overexcavation, deep foundations, loose filling, grout columns, and bulk grouting.

backfilling, historical, abandoned mines


prediction


prediction


This article gives a general discussion of voids resulting from early mining of coal, clay, and ironstone.  
backfilling, historical, coal mining, non-metal mining, abandoned mines

land-use planning, engineering, abandoned mines, coal mining

Section 59-8-312 details the rules and regulations pertaining to surface effects of underground coal mining operations in Tennessee.  
law, government, coal mining

rock mechanics, pillar strength, National Coal Board, lab testing, coal mining

subsurface subsidence damage

engineering, roof support, tunnelling

engineering, soil mechanics

motion, mine design, floor stability

mine design, ground control, mine safety, coal mining, engineering

ground control, bumps, monitoring methods

Thom, W. T. Jr. Subsidence and Earth Movements Caused by Oil Extraction, or by Drilling Oil and Gas Wells. Trans., AIME, v. 75, 1927, pp. 734-742.  
States that subsidence due to oil and gas removal is probably limited to oil fields in relatively young formations where the oil comes from loosely cemented sands or from oil-soaked clays.  
oil extraction, geologic features

engineering, construction, surface structural damage

roof support

roof stability, roof support, mine design

rock mechanics, mine design
mine operation, multiple-seam extraction, National Coal Board, coal mining

mine operation, multiple-seam extraction, National Coal Board, coal mining

mine operation, mine design

surface structural damage, surface subsidence damage

longwall, surface structural damage

subsurface water, coal mining, hydrology

Details the damaging effects of subsidence on pipelines, and suggests remedial measures to minimize this damage. The text is supplemented with both plans for subsidence-resistant pipeline designs and photographs detailing the types of damage that may be encountered in a subsidence-prone area.
subsurface structural damage, pipelines, utilities

metal mining

ground control

The mine utilized room-and-pillar methods, followed by pillar extraction. Many spontaneous multiple pillar failures resulted in surface damage and fatalities underground. The failures occurred only at a certain depth and seemed to be related to frequent rock bursts.

pillar extraction, room-and-pillar, metal mining, pillar strength, surface subsidence damage, mine safety, rock mechanics, ground control

Describes the substitution of hydraulically-emplaced unclassified tailings for previous dry filling techniques for more efficient stope filling.
backfilling

engineering, foundations, construction, surface structural damage


rock mechanics, pillar strength, lab testing, coal mining

Transactions of the Institution of Mining Engineers. A Simple Method of Water Stowage Employed at No. 5 Pit at the Escerelle Mines. v. 35, 1908, p. 79.
Details a modification of hydraulic backfilling in which fill is transported by mine car to the working level, where it is mixed with water and flushed to the required areas.
backfilling
land-use planning, prediction, fluid extraction

Details a two-dimensional computer code that couples near-and far-field response in order to effectively model subsidence caused by underground openings.
vertical displacement, horizontal displacement, computer, modeling


computer, modeling

non-metal mining

modeling

Details the application of the K. Kochmanski theory of a network nomogram to the calculation of subsidence over a horizontally extending coal seam. The text is translated from Polish to English.
vertical displacement, horizontal displacement, prediction theories, prediction, coal mining

surface water, subsurface water

Describes a series of leveling stations at the surface and in five underlying coal seams, which were to be used as a framework for more detailed leveling operations.
surface subsidence damage, survey design, coal mining, survey methods, multiple-seam extraction

The Colorado Geological Survey's responsibilities regarding inactive mine subsidence hazards are mandated by state statutes that created the present Survey in 1967 and Colorado land use laws enacted between 1972 and 1974. These laws set the stage for the Survey's review of subsidence investigations, the development of a subsidence information library which includes reports of subsidence investigations, extent of mining maps, and publications.
law, abandoned mines, land-use planning, reclamation, literature search

Describes the uses of pneumatic conveying backfilling.
backfilling, mine fires

hydrology, surface water

environment, backfilling

ground control, instrumentation, rock mechanics, mine design

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U.S. Bureau of Mines Staff. Mine Subsidence Control. Proc., U.S. Bureau of Mines Technology Transfer Seminar, Pittsburgh, PA, Sept. 19, 1985, U.S. Bureau of Mines IC 9042. Four papers are included, with topics on: effects of subsidence on water table levels, development of subsidence precalculation methodology suitable for use with the specific lithological conditions of the Pittsburgh coalbed, an engineering comparison of technologies used in surveying for longwall mine subsidence, and a comparison of the process of subsidence over 2 different longwall panels. The Bureau of Mines conducted research to develop accurate techniques of subsidence prediction which are tailored to geologic conditions specific to the United States. prediction, engineering, longwall, monitoring equipment, monitoring design, monitoring methods, survey methods, survey equipment, survey design, subsurface water, hydrology, geologic features


U.S. Code of Federal Regulations. Title 30--Mineral Resources; Chapter VII--Office of Surface Mining Reclamation and Enforcement, Department of the Interior; Subchapter K--Permanent Program Performance Standards; Part 817--Underground Mining Activities. July 1, 1984. reclamation, law

U.S. Code of Federal Regulations. Title 30--Mineral Resources; Chapter VII--Office of Surface Mining Reclamation and Enforcement, Department of the Interior; Subchapter G--Permanent Program Performance Standards; Part 783--Underground Mining Permit Applications--Minimum Requirements for Information on Environmental Resources. July 1, 1984. mine operation, law, reclamation, environment, government


U.S. General Accounting Office. Alternatives to Protect Property Owners From Damages Caused by Mine Subsidence. Rep. CED-79-25, Feb. 14, 1979, 50 pp. NTIS PB 290 869. Presents an overview of the U.S. experience with subsidence and its economic and social effects. Legislation at the Federal, State, and local levels is briefly discussed, as is the relationship between partial- and total-extraction mining methods and resulting surface subsidence. Examines 5 possible alternatives for protecting property owners from financial hardship due to mine subsidence. surface structural damage, mine design, law, insurance, partial extraction, economics


Rock mass classification systems permit comparison of conditions at a site with those described elsewhere. This study, conducted at a mine in the province of Quebec, used four different approaches to classification systems in order to obtain numerical values which are possible indicators of the qualities of local conditions in the rock mass.

rock mechanics, geotechnical, mine design


ground control, bumps, coal mining


surface structural damage


Planning of the longwall operation should take into account many factors such as seam thickness, dip, depth, roof and floor conditions, fractures pattern, etc.

longwall, roof stability, roof support, mine operation, geologic features, coal mining


surface structural damage


contains information concerning the regulations pertaining to surface effects of underground coal mining activities in Utah.

law, surface subsidence damage, government, reclamation, mine operation, coal mining


longwall


roof support, roof stability, ground control, mine safety


Current longwall panels normally incorporate the leaving of inter-panel pillars. These pillars are sometimes the cause of water accumulations on the surface. A method is described whereby the dimensions of crush pillars can be determined which do not have the same adverse effects on the surface.

pillar strength, coal mining, mine design, longwall, modeling, yielding supports, computer, multiple-seam extraction, surface structural damage, surface water, agriculture


Longwall coal mining in South Africa tends to occur at depths of around 100m below the surface. Very few shallow cases are available for analysis. The paper describes the results of an analysis of a longwall panel which was mined at a depth of 50m. It was found that the normalized surface strains did not deviate significantly from the expected values, while significantly greater tilts developed. There were also major differences between the dynamic and static profiles.

longwall, surface subsidence damage, coal mining


fluid extraction, soils


finite element method, modeling, coal mining
Van Dorpe, P. E., M. R. Howes, M. J. Miller, S. J. Lenker. Underground Mines and Related Subsidence Potential, What Cheer, Iowa. Iowa Geological Survey OFR 84-3, 1984, Iowa City, IA. Numerous subsidence events above underground mines have been reported in Iowa. This report was prepared from extant coal mine information to assist in evaluation of subsidence events and to serve as a research base.

historical, room-and-pillar, longwall, surface structural damage, agriculture, abandoned mines


rock mechanics, ground control, coal mining, roof stability


rock mechanics, roof stability, coal mining


pillar strength, ground control, rock mechanics, coal mining


pillar strength, rock mechanics, ground control, in situ testing, coal mining


environment, hydrology


law


presents a brief history of coal mining and surface protection in the Pittsburgh, PA, area. Some of the regulations covering surface protection are included.

historical, law, coal mining


surface structural damage, government, engineering, coal mining


surface structural damage, engineering, overburden, foundations


backfilling


historical, surface subsidence damage


This document consists of an 805-reference bibliography of U.S. and Canadian literature which pertains to revegetating coal-mined lands. All references are annotated and evaluated by keywords.

reclamation, literature search, environment, land-use planning, coal mining


summarizes a Bureau of Mines review of selected literature on the effects of subsidence due to high-extraction underground coal mining on farmland areas. The data are presented for
consideration in evaluating the subsidence effects due to similar mining techniques on the prime farmland areas of Illinois.


backfilling


directional


finite element method, modeling


gives a qualitative review of existing approaches to subsidence prediction; specific sections deal with both empirical and phenomenological methods. Also discussed are damage prediction and alleviation, with details on engineering design precautions and surface considerations.

vertical displacement, horizontal displacement, surface structural damage, subsurface structural damage, mine design, prediction, ground control, prediction theories


Examines the characteristics of subsidence resulting from longwall extractions. From 1969 to 1979, longwall mining of coal in the U.S. expanded from about 13 faces to over 75. The main advantage of longwall mining, which is high extraction even at great depth, also can cause significant surface movements. New regulations in the U.S. covering coal mining subsidence and reclamation operations require the mine operator to take certain steps in mine design. Specific sections qualitatively discuss the caving of strata, the effect of panel width and depth on settlement, and considerations governing panel design.

mine design, monitoring design, monitoring installation, monitoring equipment, longwall, economics, coal mining, modeling, prediction, roof stability, National Coal Board, survey design, law


directional


mine operation, pillar extraction, room-and-pillar


Research into the effects of high-extraction mining on the land surface and structures is gaining momentum but considerable research is still required to bridge the information gap. Negotiating mining and other contracts related to high-extraction mining under structures and land surfaces is a sound method of preventing problems in a field where many obstacles and pitfalls prevail.

law, surface structural damage, high-extraction retreat, longwall, pillar extraction, coal mining


roof bolting
- rock mechanics, longwall

- rock mechanics, longwall

- law, literature search

- ground control

- pillar strength, ground control, rock mechanics, coal mining

- hydrology, subsurface water, monitoring design, coal mining, monitoring methods

- geotechnical, instrumentation, monitoring design, monitoring methods

- The purpose of this work was to provide detailed information which could be used to predict certain hydrologic effects of longwall mining in the Northern Appalachian Coal Region. Results of this study indicate that water level fluctuations in the local groundwater system above longwall panels is associated with subsidence and that the static water level will generally reestablish at or near the pre-mining elevation after mining is completed.
- subsurface water, law, coal mining, longwall, hydrology, geologic features

- Efficient mining of coal overlain by saturated gravel and adjacent to the Clyde River was allowed by backfilling.
- backfilling, surface water, subsurface water, coal mining, overburden

- geophysical methods

- Examines potential modes of slope failure which can be induced in surface coal mines largely as a consequence of former underground mine workings.
- engineering, rock mechanics, abandoned mines, room-and-pillar, longwall, coal mining

- modeling

- roof stability, mine design, ground control, coal mining

- roof stability, yielding supports, coal mining
The basic The


pillar strength, in situ testing, rock mechanics, coal mining


rock mechanics


Reports a parametric study of room-and-pillar mining systems with flat and rolling strata using the finite element method idealization. The system is represented by 2-D and 3-D finite element analytical models.

finite element method, modeling, room-and-pillar, coal mining, geologic features


boundary element method, finite element method, prediction, modeling, rock mechanics


survey methods, survey design


Discusses the importance of the time factor in the study of mining subsidence and its influence on the movements accompanying an advancing face, as well as the limitations of existing methods of analysis.

vertical displacement, time factor, prediction


The concept of maximum surface subsidence is related to the area of influence, critical width and depth, and treatment of the gob.

partial extraction, multiple-seam extraction, time factor, mine operation


subsurface subsidence damage, overburden, surface subsidence damage


Contains a basic explanation of harmonic mining methods designed to negate the effects of surface strains, thereby minimizing surface damage. Also analyzes ground movements that result from an advancing face.

mine design


surface subsidence damage, mitigation, mine design, multiple-seam extraction, surface structural damage


Emphasizes the main principles of the ground deformation process, mining precautions, and structural design considerations that pertain directly to the protection of surface structures.
vertical displacement, horizontal displacement, surface structural damage, mine design, surface subsidence control, construction


Wardell, K. Surface Ground Movements Associated With the Total and Partial Extraction of Stratified Mineral Deposits. M.S. Thesis, Univ. of Nottingham, England, 1965, 187 pp. partial extraction, longwall, mine design, surface subsidence damage


Wardell, K. Ground Subsidence and Control. Min. Congr. J., v. 55, No. 1, Jan., 1969, pp. 36-42. Evaluates the mechanics of subsidence and explains how the panel-and-pillar mining system can be used to minimize ground deformations. Includes an explanation of ground deformation parameters along with mathematical formulas used for subsidence prediction. Also discusses subsidence effects on surface structures, as well as a general explanation of leveling procedures used for monitoring. vertical displacement, horizontal displacement, mine design, survey methods, mathematical modeling, surface structural damage


A novel three-dimensional numerical stress analysis method is validated by comparison with results from stressmeters monitored during panel extraction. The study shows that by choosing appropriate anisotropic rock properties, predictions of vertical stresses and surface displacements are close to observed values.

prediction, modeling, instrumentation, rock mechanics, longwall, coal mining


fluid extraction, economics


utilities, pipelines, subsurface subsidence damage, engineering, soil mechanics


surface structural damage, economics


backfilling


backfilling, lab testing


Discusses water percolation rate, cement, and vibratory compaction, which are critical in improving backfill.

backfilling


fluid extraction


Discusses the need for maximum coal extraction combined with protection of the surface; control of subsidence effects would increase with better determination of subsidence parameters. ground control, surface subsidence damage, subsurface subsidence damage, coal mining


Evaluates the design and construction of a subsidence monitoring network, and discusses methods for observation and data interpretation. Also, a mathematical solution for the principal strains of a biaxial system is reviewed.

monitoring design, monitoring installation, monitoring equipment, survey data processing, mathematical modeling


Proposes a formula stating that traveling strain is a function of distance between survey stations and rate of face advance.

survey design


prediction


floor stability

West Virginia Department of Natural Resources. West Virginia Surface Mining Reclamation Regulations. Ch. 20-26, Sec. 7, 1982, pp. 7-19 to 7-21.
Paragraph 7C provides details on the subsidence-related responsibilities of the mine operator in West Virginia.

law, mine operation


backfilling, anthracite, coal mining


Examines the similarity between the hyperbolic tangent function and a longwall subsidence profile; describes the application of this function to single panel and multipanel partial-extraction systems. A zone area system based on the use of the function and a computer method of subsidence prediction based on the National Coal Board Subsidence Engineers' Handbook is also described.

vertical displacement, horizontal displacement, National Coal Board, prediction, mathematical modeling, longwall, partial extraction, computer, zone area method, coal mining, modeling


backfilling, anthracite, coal mining


Summarizes the materials and procedures used and the results obtained in a study of a hydraulic backfilling technique. Fill material was pumped as a slurry through a closed system and widely distributed in inaccessible mine workings from a single borehole.

backfilling, abandoned mines, ground control


Describes hydraulic, pneumatic, and mechanical stowing methods; lists examples of their effectiveness.

backfilling


backfilling


backfilling


backfilling


backfilling


backfilling


backfilling


backfilling


backfilling


backfilling
backfilling

Experiments were conducted with a gelatin model to determine the relationship between subsidence parameters. Formulas of subsidence parameters were also presented.
modeling

Discusses problems associated with measurement of horizontal strains above extraction areas. survey design, instrumentation, horizontal displacement, survey methods

angle of draw, time factor, abandoned mines, multiple-seam extraction, backfilling

Results presented are from a two-dimensional model simulation of strata movement. The model shows maximum convergence growing more rapidly with increasing width than with increasing depth.
modeling

Summarizes the research conducted on the time factor in mining subsidence at four coal mines in England.
vertical displacement, horizontal displacement, time factor, partial extraction, coal mining

coal mining

floor stability, mine operation, coal mining

Discusses the likelihood of underclay squeezes based on the physical and mineral content of the clay materials.
floor stability, in situ testing, lab testing, coal mining

mine design, longwall

ground control

mine design, longwall, ground control, mine waste, mine operation

monitoring design, monitoring methods, survey methods, instrumentation, survey design, geotechnical

mine design, longwall, ground control, coal mining

mine design, longwall, ground control

overburden, rock mechanics, subsurface subsidence damage, coal mining


Describes the principles of mining subsidence associated with the working of predominantly level coal seams, surface structural damage, subsurface structural damage, geologic features, coal mining, geotechnical


Reviews coal mining subsidence knowledge and related problems due to longwall extraction in England, with consideration given to findings based on modeling of surface subsidence by a finite element method. Presents and discusses the results of isotropic and anisotropic solutions. vertical displacement, horizontal displacement, longwall, prediction, modeling, finite element method, coal mining


mine design, room-and-pillar, subsurface water, coal mining


This paper gives a general review of subsidence characteristics associated with longwall mining; it describes test instruments designed to investigate the zones of increased permeability resulting from longwall extraction. surface water, subsurface water, survey equipment, longwall, hydrology


longwall, rock mechanics


room-and-pillar, surface subsidence damage, coal mining


overburden, longwall, subsurface water, hydrology, rock mechanics, coal mining


geologic features, tunnelling, roof support


computer, survey methods, survey data processing


mine operation, mine safety, survey methods, photography, coal mining


roof stability, photography, coal mining


ground control

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rock mechanics, lab testing

rock mechanics, lab testing

abandoned mines, coal mining

Examines the geologic conditions, mining history, and subsidence trends and damage in the area. A large section is devoted to detailed analyses of sinkholes and the mechanisms of sinkhole formation.
vertical displacement, horizontal displacement, surface structural damage, abandoned mines, coal mining

surface structural damage, abandoned mines, coal mining

surface structural damage, abandoned mines, coal mining

Describes use of sand-cement mixtures, as stope filling, to reduce preparation time and increase efficiency.
backfilling, economics

backfilling, anthracite, coal mining

environment, land-use planning

hydology, subsurface water, coal mining, surface water

abandoned mines, coal mining

rock mechanics, in situ testing

roof to floor convergence of an adequately supported longwall face depends upon several factors, including face advance, extraction height, and depth of the working.
mine design, mine waste, ground control, roof stability, floor stability, longwall, prediction

pillar strength

room-and-pillar, ground control, mine design, pillar strength

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   mine design, ground control, longwall, roof support, roof stability

   metal mining, geologic features

   fluid extraction

   floor stability

   fluid extraction, pipelines, utilities

   law

   rock mechanics, lab testing

   rock mechanics, lab testing

Winstanley, A. Longwall Roof Control. Trans., Inst. of Mining Engineers, v. 81, 1930-31, pp. 373-405; v. 82, 1931-32, pp. 107-109, 334-337.
   Presents convergence studies of roof control; discusses the use of packing for roof support.
   longwall, roof support

   ground control

   Discusses background, current regulations, recent developments, and related issues of the Surface Mining Control and Reclamation Act (SMCRA) which was enacted on Aug. 3, 1977.
   law, government, reclamation

   fluid extraction, subsurface water, hydrology

   fluid extraction, surface water

   Discusses the effects of mining subsidence on ground water.
   subsurface water, hydrology, mitigation

   roof bolting, coal mining

Underground Digitilt backfilling program 1986, NTIS S.

Effects high-extraction R.


land-use planning


Evaluates the effectiveness and characteristics of types of mine waste as a backfilling material for use in active and abandoned coal mines.

backfilling, mine waste, abandoned mines, active mines, coal mining


Water-pumping stations were de-watering magnesian limestones and causing subsidence which was often blamed on the extraction of the coal far below.

subsurface water, fluid extraction, coal mining


Discusses the mechanics of various methods of roof support in mines, including roof bolts, timbering, and backfilling.

roof support, backfilling, roof bolting, coal mining, metal mining


top bolting


shortwall, rock mechanics


surface structural damage


surface structural damage, engineering, geotechnical, insurance, monitoring methods, survey methods, coal mining


The Illinois Mine Subsidence Insurance Fund and the U.S. Bureau of Mines, Twin Cities Research Center have chosen the Digitilt Tiltmeter as an instrument to monitor structural response to ground movements induced by coal mine subsidence. The Fund and the Bureau sponsored a program to construct and monitor two 30x40 ft foundations in front of a high-extraction panel in Sesser, IL.

Foundations, monitoring equipment, computer, surface structural damage, high-extraction retreat, monitoring methods, coal mining


fluid extraction, oil extraction


engineering, construction, prediction, surface structural damage


Evaluates criteria for site exploration and development, risk assessment, and housing construction in areas of actual and potential mine subsidence. Suggested measures to mitigate damage to housing are also given. The appendix explains a mathematical model which can be used for the prediction of subsidence profile characteristics.

vertical displacement, horizontal displacement, surface structural damage, subsurface damage control, construction, mathematical modeling, prediction, engineering


engineering, construction, prediction, surface structural damage


Contains observations of subsidence of a salt well in Kansas, as well as a description of subsidence over a sulfur deposit.

non-metal mining, surface subsidence damage


This bulletin summarized current knowledge (1916) of mine subsidence in Illinois, Pennsylvania, and West Virginia.

vertical displacement, horizontal displacement, surface structural damage, subsurface structural damage, surface water, subsurface water, mine design, backfilling, law, literature search, coal mining, historical


Examines subsidence at the time (1916) due to mining operations in Illinois.

carbon mining, surface structural damage, subsurface structural damage, mine design, historical, backfilling, room-and-pillar, ground control, descriptive theories


carbon mining, roof support, time factor, active mines


roof bolting, ground control


Unmined blocks in the Sewickley seam surrounded by worked out areas had been found to transmit overburden loads through the interval strata to the Pittsburgh seam 90 feet below.

multiple-seam extraction, overburden


Evaluates the factors which affected the mine layout, mining equipment, and economics of the mining systems used in the United States at the time (1969).

mine design


Presents a description of the shortwall concept and proposed methods of utilizing it to increase production.

law, mine safety, shortwall, roof support, coal mining


Discusses the theoretical analysis of Bals' and Knothe's methods of subsidence prediction.

vertical displacement, horizontal displacement, prediction theories, prediction


Many subsidence researchers in the U.S. have developed new empirical function methods to predict subsidence, or attempted to validate some empirical functions developed by foreign
researchers for use in the U.S. An attempt is made in this paper to develop a new empirical function to predict a surface subsidence basin due to longwall mining.

prediction theories, computer, longwall, coal mining


The probability function integration method is one of the influence function methods. It is a widely accepted method in many mining districts in China and Poland mainly because its theory and formulae can well represent the surface subsidence basins due to longwall mining of flat or near-flat seams.

prediction theories, influence function, surface structural damage


ground control, instrumentation


economics


This report consists of an extensive historical survey and bibliography of theories, remedies, and laws concerning surface subsidence.

economics, surface subsidence damage, historical, backfilling, law, literature search

computer

construction

descriptive theories

economics

elastic theory

monitoring installation

monitoring methods

Multiple-seam extraction
National Coal Board


non-metal mining


oil extraction


overburden


partial extraction


photography


pillar extraction

surface water


survey data processing


survey design


survey equipment


survey methods
