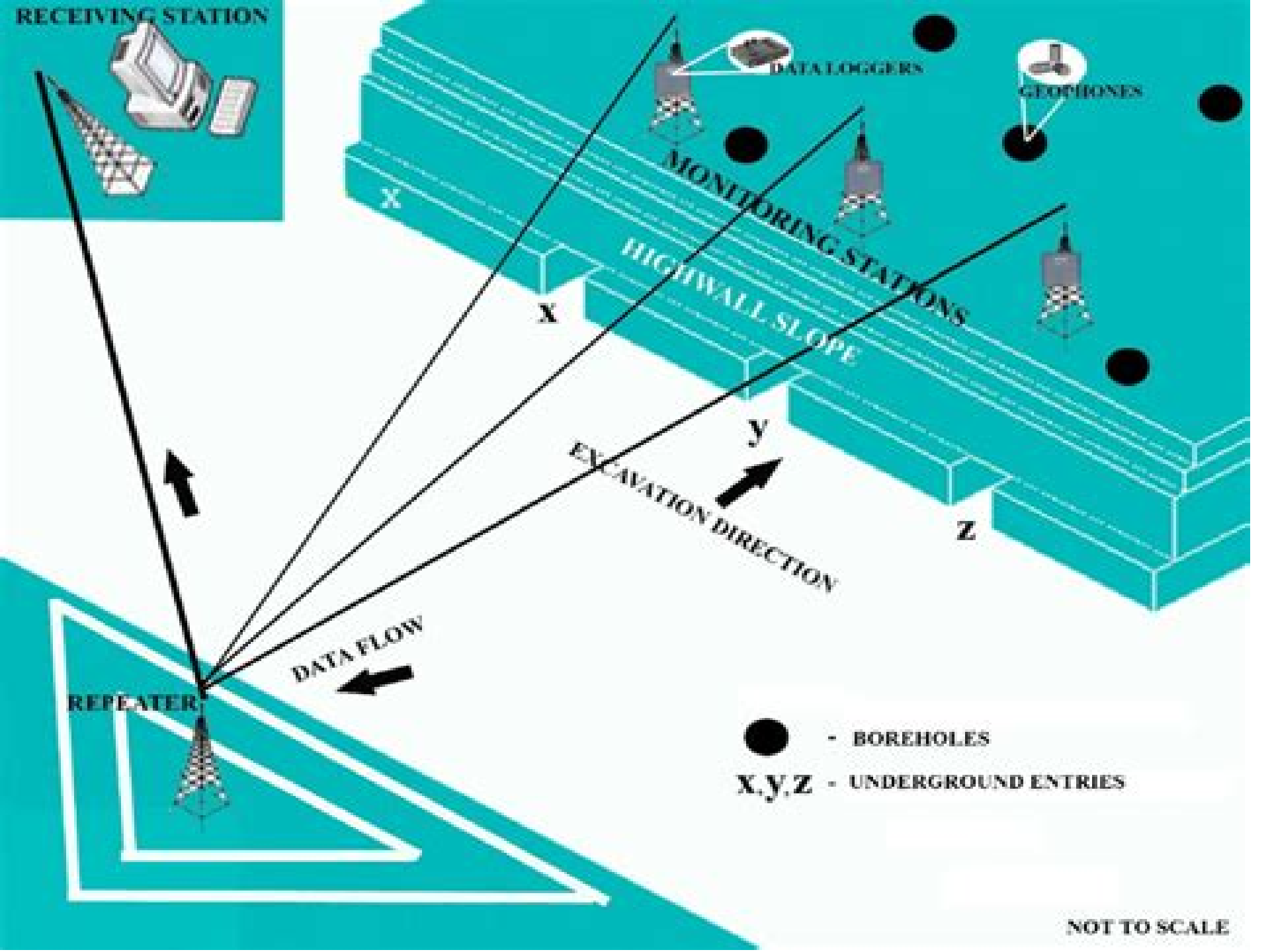
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NOT TO SCALE

Seismic Monitoring In Mines

Eystein S. Husebye,Anton M. Dainty

Seismic Monitoring In Mines:

Seismic Monitoring in Mines A.J. Mendecki,1996-12-31 Routine seismic monitoring in mines was introduced over 30 years ago with two main objectives in mind immediate location of larger seIsmIC events to guide rescue operations prediction of large rockmass instabilities The first objective was achieved fairly quickly but with the subsequent development of mine communication systems its strategic importance has diminished The very limited success with prediction can at least partially be attributed to three factors seismic monitoring systems based on analogue technology that provided noisy and frequently poorly calibrated data of limited dynamic range the non quantitative description of a seismic event by at best its local magnitude and the resultant non quantitative analysis of seismicity frequently through parameters of some statistical distributions with a somewhat loose but imaginative physical interpretation The introduction of modern digital seismic systems to mines and progress in the theory and methods of quantitative seismology have enabled the implementation of realtime seismic monitoring as a management tool quantifying rockmass response to mining and achieving the first tangible results with prediction A seismic event being a sudden inelastic deformation within the rockmass can now routinely be quantified in terms of seismic moment its tensor and radiated seismic energy so that the overall size of and stress released at the seismic source can be estimated **Seismic Monitoring in Mines** A.J. Mendecki,2012-12-06 Routine seismic monitoring in mines was introduced over 30 years ago with two main objectives in mind immediate location of larger seIsmIC events to guide rescue operations prediction of large rockmass instabilities The first objective was achieved fairly quickly but with the subsequent development of mine communication systems its strategic importance has diminished The very limited success with prediction can at least partially be attributed to three factors seismic monitoring systems based on analogue technology that provided noisy and frequently poorly calibrated data of limited dynamic range the non quantitative description of a seismic event by at best its local magnitude and the resultant non quantitative analysis of seismicity frequently through parameters of some statistical distributions with a somewhat loose but imaginative physical interpretation The introduction of modern digital seismic systems to mines and progress in the theory and methods of quantitative seismology have enabled the implementation of realtime seismic monitoring as a management tool quantifying rockmass response to mining and achieving the first tangible results with prediction A seismic event being a sudden inelastic deformation within the rockmass can now routinely be quantified in terms of seismic moment its tensor and radiated seismic energy so that the overall size of and stress released at the seismic source can be estimated *Mine Seismology: Data Analysis and Interpretation* S.N. Glazer,2016-04-27 This book offers an in depth analysis and interpretation methods applicable to mine induced seismicity It is based on over 40 years of experience in mine and exploration geophysics Another unique feature of this book is the complete history of the caving process as evidenced by the recorded seismicity at the South African copper mine Palabora Lift 1 Until now the literature has only presented theory and case studies discussing the

interpretation of results and there has been no discussion of the input data quality or why a certain interpretation technique was applied This book fills that gap This book is a fascinating read written by one of the world s leading mine seismologists It summarises the history and progression of mine seismology It outlines the practical use of back analysis of data and how it can be used on a daily basis The book explains how mine seismology can be used as an effective monitoring tool for key events as the mine progresses as well as for future caving operations Anthony Allman MAusIMM CP Min RPEQ Antcia Consulting Pty Ltd Director Mining Engineer The content of the book is really solid and robust and I have no doubt it is going to be considered a great contribution for the mining community Raul Fuentes Former Director of Master Program in Geomechanics Applied to Mining Universidad de los Andes Santiago Chile This book is long overdue and helps to present some difficult concepts in a way that they can be clearly understood by non experts in this area Stefan has personally managed to take mine seismology from being a black art into a useful tool to help make mines a safer and more controlled environment Neil Hepworth C Eng MIMMM Geomin Consultorio Brazil Consultant Mining and Geotechnics Seismic monitoring is an important tool in cave management The information from monitoring allows a number of key production factors to be determined including cave advance rates the approximate location of the cave back insight into the size of the air gap and allows the tracking of broad changes in stress These all assist in the day to day management of a safe and successful cave Dr Glazer s book provides guidance on the application of microseismicity to cave management through a review of appropriate theory and more importantly illustrates its use through case histories particularly from the Palabora block cave The text will be a good addition for all practitioners in cave engineering and operations Allan Moss General Manager Grasberg Underground Liaison Copper Development Rio Tinto **Seismicity in Mines** G. Gibowicz,2012-12-06 Recent seismological research has focused on processes other than pure shear failure double couple as an alternative mechanism for some types of seismic events This has been stimulated by what appears to be anomalous focal mecha nisms observed for several earthquakes of possible volcanic nature in the 1980 Mammoth Lakes California sequence JULIAN and SIPKIN 1985 SIPKIN 1986 Although studies have concentrated on earthquakes associated with magmatic processes possible non double couple seismic failure has been observed but not widely known in cases of mine seismicity in the past three decades Such cases have occurred on a world wide basis however no cases until now have been observed in the United States The existence of non double couple failure in mine seismicity has been controversial as it has been for tectonic volcanic earthquakes Several of the benchmark studies of mine seismicity in the deep South African gold mines have resulted in the belief that no fundamental distinction in the source mechanism exists between tectonic earthquakes and rock bursts MCGARR 1984 both types of events are the result of pure shear failure However the reported cases of implo sional focal mechanisms for mine seismicity continue to increase in number and prolong the controversy During the summer of 1984 a three dimensional high resolution micro earthquake network was operated by Woodward Clyde Consultants WCC in the

vicinity of two coal mines beneath Gentry Mountain in the eastern Wasatch Plateau of central Utah Mine Seismology: Seismic Warning Concept S.N. Glazer,2017-10-03 This book illustrates how mine seismology can be used to improve underground safety standards It describes several preventive actions that have been put into practice at the 5B Area of No 5 Shaft Vaal Reefs gold mine after issuing seismic warnings These included additional safety pillars changes in mining sequences and directions and a review of the mining strategy for the entire 5B area The presented experiment with seismic warning concept was a success because it was an internal mine project Further the Vaal Reefs management adopted the philosophy that the success rate should be measured in the preventive actions taken not in the success of the prediction itself Reviewing these and other aspects the book clearly demonstrates how mine seismology can effectively improve underground safety standards Stefan Glazer s book addresses in a very comprehensive manner both technical and practical problems of implementing and then effectively using microseismic networks and data Stefan proves that through comprehensive microseismic data analysis the location of potential rock burst can be assessed and then prevention action plans can be developed providing more confidence to management and workers that deposit s can be mine d safely Michal Stawski VP Strategic Geomechanical Specialist PT Freeport Indonesia I began reading this story expecting to find a technical review of the science of seismology and its application in mining but this book is much more than that This is a must read for those managing seismically active mines and should provide a wake up call to the industry as the complex morality surrounding the management of seismic risk needs to be clarified in order for this to advance Eric Strom Director Underground Mining New Gold Inc As a mining geotechnical practitioner having experience in large open pit and underground massive mining operations I have learned that mining induced seismicity can have a significant impact on the safety and economics of operations However seismicity is a complex field that is generally left to specialists with little input from geotechnical engineers and engineering geologists This is a must read for mine seismologists geotechnical practitioners and mining engineers alike and will be a welcome and much needed addition to my own book cabinet This will be an invaluable work as our industry progresses to the mining of new depths in both the underground and open pit environments Desmond Mossop Pr Sci Nat Principal Engineering Geologist SRK Consulting **An Introduction to Mining Seismology** Slawomir Jerzy Gibowicz,Andrzej Kijko,2013-10-22 An Introduction to Mining Seismology describes comprehensively the modern methods and techniques used to monitor and study seismicity and rockbursts in mines Key case histories from various worldwide mining districts clearly illustrate and skillfully emphasize the practical aspects of mining seismology This text is intended as a handbook for geophysicists and mining and rock mechanics engineers working at mines It will also serve as an essential reference tool for seismologists working at research institutions on local seismicity not necessarily induced by mining Presents a comprehensive description of seismicity induced by mining worldwide Provides information on optimum network planning and seismic event location procedures in deep mines Covers a broad array of topics including focal mechanism

moment tensor and double couple versus non double couple seismic events in mines Includes data on source parameters and scaling relations for seismic events in mines Monitoring a Comprehensive Test Ban Treaty Eystein S. Husebye,Anton M. Dainty,2012-12-06 An international treaty banning the testing of any nuclear device in any environment a comprehensive test ban treaty CTBT has been on the political agenda for nearly 40 years Objections to a CTBT have been political technical or a combination of both However the possibilities seem better after the end of the Cold War In the prevailing cooperative disarmament climate a CTBT appears likely to be approved by most countries in 1996 Hence the great current interest in monitoring technologies and capabilities Such issues are comprehensively addressed here a preamble being devoted to the political developments and setbacks over the past 40 years Since seismic means are considered the dominant monitoring element they are explored in detail Contributions cover network deployments advanced signal processing wave propagation in heterogeneous media and seismic source representations and a variety of techniques for source classification including neuralnetworks Complementary monitoring techniques such as hydroacoustics radionuclides and infrasound are also summarised The IAEA operation for monitoring compliance with the Non Proliferation Treaty is also presented The book also includes eyewitness accounts of the Soviet 50 Mt megabomb development and test as well as the efforts made by the state to monitor the nuclear test programmes of the western powers Includes some 33 articles written by distinguished scientists active in CTBT monitoring research for decades **Passive Seismic Monitoring of Induced Seismicity** David W. Eaton,2018-04-26 An introduction to the principles and applications of passive seismic monitoring providing an accessible overview of current research and technology **Mine Seismology: Seismic Response to the Caving Process** S.N. Glazer,2018-08-01 This book presents the results of seismic data analysis and interpretation based on nearly one million seismic events This seismicity was induced by the caving process in four copper mines each located on a different continent The book not only serves as an interpretation guide it also illustrates the benefits of evaluating data from different mines How to establish which seismic data base is faulty and why The formation of a universal seismic response to the caving process Indisputable evidence that hydro fracturing improves underground safety This book invites discussion on more general aspects of research such as Basic research applied research and implementation Predicting mine induced seismic events Quantitative versus qualitative seismology Research versus pseudo research What is genuine research In the Parlabora Mine Stefan has demonstrated that the use of the seismic system was a very practical means of monitoring the progression of the cave up to and beyond break through into the open pit above The seismic system was vital in drawing up the undercutting and seismic protocols and determining the maximum potential seismic hazard level Peter Townsend Retired Mine Manager and Consultant I consider Stefan the pioneer of using microseismic data to provide understanding of the mechanism and progress of cave mining Science has advanced considerably since the use of less than reliable extensometers to monitor the cave back position and Stefan was leading this advance This book provides a lot of useful insight s in how we

can best understand the data that we gather and how to change this data into useful information Neil Hepworth C Eng MIMMM Geomin Consultorio Brazil Consultant Mining and Geotechnics Stefan mine seismology trilogy is a comprehensive tutoring on how to analyse and interpret mine induced seismicity This coaching is based on multiple practical examples presented from the problem to be solved with input data tests followed by analysis and interpretation This last is presented with many details that explain the whole process Mahdi Bayuargo ST MAScPT Duaem Gada Bayuagus Managing Director

Hydropower Hossein Samadi-Boroujeni,2012-03-09 Hydroelectric energy is the most widely used form of renewable energy accounting for 16 percent of global electricity consumption This book is primarily based on theoretical and applied results obtained by the authors during a long time of practice devoted to problems in the design and operation of a significant number of hydroelectric power plants in different countries It was preferred to edit this book with the intention that it may partly serve as a supplementary textbook for students on hydropower plants The subjects being mentioned comprise all the main components of a hydro power plant from the upstream end with the basin for water intake to the downstream end of the water flow outlet **Advances in Geophysics** ,2000-10-17 This series provides a venue for longer reviews of current advances in geophysics Written at a level accessible to graduate students the articles serve to broaden knowledge of various fields and may be useful in courses and seminars **Seismicity Associated with Mines, Reservoirs and Fluid Injections** Shahrian Talebi,2012-12-06 This volume contains 18 papers from 8 countries dealing with different aspects of triggered and induced seismicity In situ observations of the phenomenon include examples of seismicity due to reservoirs hard rock mines coal mines mine collapses brine production caverns fluid injections and geothermal hot dry rock projects High frequency acoustic emission studies from laboratory experiments and hard rock mines have also been reported Besides providing case studies of previously unavailable observations of seismicity the present volume contains investigations of the causes and source mechanism of seismic events determination of source parameters seismic hazard as related to the design of support systems for underground openings and procedures for closure of brine production caverns and the use of seismic and non destructive techniques in assessing rock damage measuring dynamic elastic moduli and detecting discontinuities This collection of papers provides an excellent indication of the state of the art recent developments and outstanding challenges facing scientists and engineers in understanding the causes and alleviating the effects of induced seismicity *Utah Mine Disaster and Preventing Future Tragedies* United States. Congress. Senate. Committee on Appropriations. Subcommittee on Departments of Labor, Health and Human Services, Education, and Related Agencies,2008

Microseismic Monitoring Vladimir Grechka ,Werner M. Heigl ,2017-09-01 Over the past decade microseismic monitoring a technology developed for evaluating completions of wells drilled to produce hydrocarbons from unconventional reservoirs has grown increasingly popular among oil and gas companies Microseismic Monitoring by Vladimir Grechka and Werner M Heigl discusses how to process microseismic data what can and cannot be inferred from such data and to what

level of certainty this might be possible The narrative of the book follows the passage of seismic waves from a source triggered by hydraulic fracture stimulation through hydrocarbon bearing formations towards motion sensors The waves characteristics encode the location of their source and its focal mechanism The analysis of various approaches to harvesting the source related information from microseismic records has singled out the accuracy of the velocity model fully accounting for the strong elastic anisotropy of hydraulically fractured shales as the most critical ingredient for obtaining precise source locations and interpretable moment tensors The ray theory complemented by its modern extensions paraxial and Fr chet ray tracing provides the only practical means available today for building such models The book is written for geophysicists interested in learning and applying advanced microseismic data processing techniques Rockbursts and Seismicity in Mines 93 R. Paul Young,1993-01-01 These proceedings include the latest developments in research and practice in the area of mining induced seismicity Three themes are explored strong ground motion and rockburst hazard mechanics of seismic events and stochastic methods and monitoring of seismicity and geomechanical modelling *SME Mining Engineering Handbook, Third Edition* Peter Darling,Society for Mining, Metallurgy, and Exploration (U.S.),2011 This third edition of the SME Mining Engineering Handbook reaffirms its international reputation as the handbook of choice for today s practicing mining engineer It distills the body of knowledge that characterizes mining engineering as a disciplinary field and has subsequently helped to inspire and inform generations of mining professionals Virtually all of the information is original content representing the latest information from more than 250 internationally recognized mining industry experts Within the handbook s 115 thought provoking chapters are current topics relevant to today s mining professional Analyzing how the mining and minerals industry will develop over the medium and long term why such changes are inevitable what this will mean in terms of challenges and how they could be managed Explaining the mechanics associated with the multifaceted world of mine and mineral economics from the decisions associated with how best to finance a single piece of high value equipment to the long term cash flow issues associated with mine planning at a mature operation Describing the recent and ongoing technical initiatives and engineering developments in relation to robotics automation acid rock drainage block caving optimization or process dewatering methods Examining in detail the methods and equipment available to achieve efficient predictable and safe rock breaking whether employing a tunnel boring machine for development work mineral extraction using a mobile miner or cast blasting at a surface coal operation Identifying the salient points that dictate which is the safest most efficient and most versatile extraction method to employ as well as describing in detail how each alternative is engineered Discussing the impacts that social and environmental issues have on mining from the pre exploration phase to end of mine issues and beyond and how to manage these two increasingly important factors to the benefit of both the mining companies and other stakeholders **Rockburst** Xia-Ting Feng,2017-10-19 Rockburst Mechanisms Monitoring Warning and Mitigation invites the most relevant researchers and practitioners worldwide to discuss the rock mechanics phenomenon

related to increased stress and energy levels in intact rock introduced by drilling explosion blasting and other activities When critical energy levels are reached rockbursts can occur causing human and material losses in mining and tunneling environments This book is the most comprehensive information source in English to cover rockbursts Comprised of four main parts the book covers in detail the theoretical concepts related to rockbursts and introduces the current computational modeling techniques and laboratory tests available The second part is devoted to case studies in mining coal and metal and tunneling environments worldwide The third part covers the most recent advances in measurement and monitoring Special focus is given to the interpretation of signals and reliability of systems The following part addresses warning and risk mitigation through the proposition of a single risk assessment index and a comprehensive warning index to portray the stress status of the rock and a successful case study The final part of the book discusses mitigation including best practices for distressing and efficiently supporting rock Designed to provide the most comprehensive coverage the book will provide practicing mining and tunneling engineers the theoretical background needed to better cope with the phenomenon practical advice from case studies and practical mitigation actions and techniques Academics in rock mechanics will appreciate this complete reference to rockburst which features how to analyze stress signals and use computational modeling more efficiently Offers understanding of the fundamental theoretical concepts of rockbursts Explores how to analyze signals from current monitoring systems Shows how to apply mitigating techniques in current work Identifies characteristics that should be measured in order to detect rockburst risk **Rockburst in Extra-Thick Coal Seam Mining: Mechanism and Prevention** Sitao Zhu,Fuxing Jiang,Xiufeng Zhang,Jinhai Liu,2024-08-02 This book provides a detailed introduction to the mechanism of rockburst in extremely thick coal seam mining and explores the mechanical mechanism on why the critical depth of rockburst in extremely thick coal seam mining is significantly smaller than that in thin to thick coal seams it also proposes targeted monitoring warning and treatment technologies The prevention and control of coal mine rockburst is a global problem attracting engineers and scientists from various disciplines such as mining geology geophysics and civil engineering to conduct research This book provides multiple case studies of rockburst accidents in mining of ultra thick coal seams and provides a detailed analysis of the mechanisms and treatment technologies of each rockburst accident It aims at graduate students researchers and on site engineers who are interested in the mechanism of rockburst occurrence monitoring early warning and treatment technology The translation was done with the help of artificial intelligence The present version has been revised technically and linguistically by the authors in collaboration with a professional translator

Rockbursts Wilson Blake,D. G. F. Hedley,2003 Using a series of case studies this essential reference documents the experiences of 15 of the most rockburst prone mines in the U S and Canada over the last century The book provides an historical analysis of rockburst activity along with state of the art strategies for anticipating and preventing this dangerous and disruptive phenomenon Inventory of Federal Energy-related Environment and Safety Research for ... ,1980

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Seismic Monitoring In Mines Introduction

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