

318 5.553 H 1000
17-033

STRATA CONTROL IN MINERAL ENGINEERING

Z.T. BIENIAWSKI

*Professor of Mineral Engineering and Director
Mining and Mineral Resources Research Institute
The Pennsylvania State University*



A.A.BALKEMA / ROTTERDAM / 1987

Contents

PREFACE	IX
1 IMPORTANCE OF STRATA CONTROL FOR MINERAL AND ENERGY DEVELOPMENT	1
Strategic minerals and metals	1
Energy demand and supply	4
References	10
2 STATE-OF-THE-ART IN STRATA CONTROL PRACTICE	11
Predominant mining methods	11
The design concepts in rock engineering	13
Importance of geotechnical data	21
Latest developments	21
Innovations in the USA	24
References	26
3 STRATA REINFORCEMENT BY ROCK BOLTING	29
Mechanism of rock-support interaction	29
Development of rock bolting	31
Mechanical rock bolts	31
Grouted rock bolts	35
Design guidelines for rock bolt systems	37
Worked example	54
References	56
4 STABILITY OF ROCK PILLARS	59
Pillar stability and stiffness	59
In-situ large-scale tests on rock pillars	65

Determination of pillar strength	77
References	87
5 CONTROL OF FLOOR FAILURE	91
Historical background	91
Bearing capacity analysis	93
In-situ determination of bearing capacity	103
Deformation characteristics of floor strata	104
Heave factor analysis	104
Control of floor failure with yielding pillars	107
References	108
6 STRATA CONTROL IN LONGWALL MINING	111
Longwall practices in the USA	112
Strata mechanics	114
Design considerations	123
Surface subsidence due to longwall mining	131
References	131
7 ROCKBURSTS - THEIR MECHANISM AND CONTROL	135
Recent research findings	135
Rockburst occurrence	137
Observations and data analyses	140
The energy balance	141
Mechanism of rockbursts: The kinetic energy source	144
Control of rockburst hazard	145
References	146
8 STRATA CONTROL IN SHAFT DESIGN AND CONSTRUCTION	149
Construction techniques	149
Design guidelines for strata control in shaft sinking	158
References	163
9 MINING FOR OIL - INNOVATIONS IN ENERGY DEVELOPMENT	165
Definitions	167
Occurrence and history	167
Heavy oil mining methods	169
Oil shale mining	170
Underwater tunneling for oil	171
Oil storage in mined caverns	173
References	175

10 TUNNELING FOR STORAGE - NUCLEAR WASTE DISPOSAL IN DEEP UNDERGROUND REPOSITORIES	177
Program objectives	178
Status of nuclear waste disposal program in the USA	178
Exploration for repository siting	184
In-situ testing at repository sites	187
Repository design concepts	197
Strata control aspects of repository design	198
Geotechnical challenges	200
References	200
BIBLIOGRAPHY: RECENT LITERATURE SOURCES ON STRATA CONTROL IN MINERAL ENGINEERING	203
AUTHOR INDEX	207
SUBJECT INDEX	211