01 Jan 2020

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Recommended Citation

M. M. Murphy et al., "Guest Editorial-Special Issue on Ground Control in Mining in 2019," *International Journal of Mining Science and Technology*, vol. 30, no. 1, pp. 1-2, China University of Mining and Technology, Jan 2020.

The definitive version is available at https://doi.org/10.1016/j.ijmst.2019.12.008

International Journal of Mining Science and Technology 30 (2020) 1–2

Contents lists available at ScienceDirect

International Journal of Mining Science and Technology

journal homepage: www.elsevier.com/locate/ijmst

Guest editorial-special issue on ground control in mining in 2019

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Ground control is the science of studying and controlling the behavior of rock strata in response to mining operations. Ground-control-related research has seen significant advancements over the last 39 years, and these accomplishments are well documented in the proceedings of the annual International Conference on Ground Control in Mining (ICGCM) [1]. The ICGCM is a forum to promote closer communication among researchers, consultants, regulators, manufacturers, and mine operators to expedite solutions to ground control problems in mining [2–7]. Fundamental research and advancements in ground control science define the central core of the conference mission. Providing information to mine operators is a priority, as the conference goal is to offer solutions-oriented information. In addition, the conference has included innovative technologies and ideas in mining-related fields such as exploration, geology, and surface and underground mining in all commodities. Many new ground control technologies and design standards adopted by the mining industry were first discussed at ICGCM. Therefore, this conference is recognized as the best international forum for introducing new ground-control-related research and products.

Professor Syd Peng (West Virginia University), on his own initiative, organized the First Conference on Ground Control in Mining in the summer of 1981. Dr. Peng keenly recognized that in order to advance the state-of-the-art in ground control, a forum was urgently needed whereby researchers, practitioners, equipment manufacturers, and government regulators could meet regularly and exchange information in a timely manner. Since 2016, the conference has been administered by the Society for Mining, Metallurgy & Exploration (SME). Five researchers, Ted Klemetti (NIOSH, Pittsburgh Mining Research Division), Brijes Mishra (West Virginia University), Kyle Perry (Missouri University of Science and Technology), Heather Lawson (NIOSH, Spokane Mining Research Division), and Michael Murphy (NIOSH, Pittsburgh Mining Research Division), currently serve as the lead team from the conference's organizing committee to ensure that the ICGCM continues to advance the science of ground control and develop solutions for difficult problems through innovative mine design strategies, operational practices, and engineering interventions. Brijes Mishra served as conference chair for the 36th and 37th conferences, while Ted Klemetti served as the conference chair for the 38th conference and will continue serving for the upcoming 39th conference in July 2020.

The 38th International Conference on Ground Control in Mining was held on July 23–26, 2019, in Morgantown, WV. This year's event had 179 attendees with representation from academia (28%), operators (20%), equipment manufacturers (13%), government researchers (12%), and government regulators (10%). The international community was represented with 24 attendees from five countries, with China sending thirteen representatives and Australia sending six. In addition to a presence from the coal industry, attendees from the limestone and oil and gas industries were also represented. The event included 44 presentations in 10 different sessions during the three-day conference. The 38th conference included a one-time panel discussion on issues related to the interface of coal mining and natural gas development. The panel included representatives from the Pennsylvania Department of Environmental Protection, CONSOL Energy, EQT Corporation, the Mine Safety and Health Administration (MSHA), and the National Institute for Occupational Safety and Health (NIOSH).

The topics covered at this year's conference included a wide range of subjects including coal mine ground control, longwall mining interactions with oil and gas wells, emerging issues and studies in underground stone mines, and subsidence and related surface issues. Dr. Russell Frith (Mine Advice Pty. Ltd) opened up the conference and presented "A Causation Mechanism for Coal Bursts during Roadway Development Based on the Major Horizontal Stress in Coal, Very Specific Structural Geology Causing a Localised Loss of Effective Coal Confinement and Newton's Second Law." This paper outlines what is considered to be a credible, first principles, mechanistic explanation for three current development coal burst conundrums referenced in a previous ICGCM publication [8]. Dr. Frith presented early published coal testing work examining the significance of a lack of "constraint" to coal stability and an understanding of how very specific structural geology and other geological features can logically cause bursts to occur in situ, albeit on a statistically very rare basis. The model proposed by Dr. Frith could also form the basis for a robust, risk-based approach utilizing a "hierarchy of controls" to the operational management of the

Received 25 July 2019; Revised 27 August 2019; Accepted 26 September 2019.
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https://doi.org/10.1016/j.ijmst.2019.12.008
2095-2686/

development coal burst threat. Specifically, the approach includes the use of pre-mining predictions for likely burst-prone and non-burst-prone areas, the use of the mine layout to avoid or at least minimize mining within burst-prone areas if appropriate, and finally the development of an operational Trigger Action Response Plan that reduces the likelihood of inadvertent roadway development into a burst-prone area without suitable safety controls already being in place. The presentation was followed by Dr. Bruce Hebblewhite (University of New South Wales) who discussed "Fracturing, Caving Propagation and Influence of Mining on Groundwater above Longwall Panels-A Review of Predictive Models." This presentation explored the nature of fracturing above longwall panels in underground coal mining. The major prediction models were reviewed in the context of observed behavior of strata displacement and fracturing above longwall panels in the Southern Coalfields of New South Wales. Dr. Hebblewhite also discussed the parameter often referred to as "height of fracturing" in terms of the critical parameters that influence it, and the relevance and appropriateness of this terminology in the context of overlying subsurface subsidence and groundwater impact. Dr. Hebblewhite proposed an alternative terminology for this parameter that better reflects what it is and how it is used.

After the opening session on focusing on coal mine ground control, a session dedicated to longwall mining interactions with oil and gas wells was held. Case histories and roof control research were also highlighted during the first day of the conference. Mr. Greg Rumbaugh and Dr. Christopher Mark (MSHA) opened the session with "Assessing Risks from Mining-Induced Ground Movements near Gas Wells." The presentation overviewed recent events during well-drilling activities in southwestern Pennsylvania that indicated failures in the production string and protective casings during hydraulic fracturing and completion operations during well commissioning. Mr. Rumbaugh discussed mining-induced ground movements that may cause well damage, including conventional subsidence, nonconventional subsidence (e.g., bedding plane slip), pillar failure, and floor instability. The presentation then described known risk factors for each of the four failure mechanisms and discussed framework that can guide the risk assessment process when mining takes place near gas or oil wells. Dr. Peter Zhang (NIOSH) then followed with "Influence of Longwall Mining on the Stability of Gas Wells in Chain Pillars." Dr. Zhang's study presented seven cases of conventional gas wells penetrating through longwall chain pillars in the Pittsburgh coal seam. The study indicated that overburden depth and pillar size are not the only determining factors for gas well stability. The other important factors also include subsurface ground movement, overburden geology, and weak floor, as well as the construction of gas wells. The study also demonstrated that numerical models can predict with reasonable accuracy the subsurface deformations in the overburden above, within, and below the chain pillars and the potential location and modes of gas well failures, therefore providing a more quantifiable approach to assess the stability of the gas wells in longwall chain pillars.

The conference also included a dedicated session on emerging issues and studies in underground stone mines. Dr. Christopher Newman (Appalachian Mining & Engineering, Inc.) presented "The Development of a Multiple Level Underground Limestone Mine from Geology through Mine Planning," which highlighted optimization of reserve recovery by planning a multiple-level stone mine from the lowest level and progressing up. The multiple-level mine design process and related decisions were presented through a case history example. The premise is that there is one opportunity to "get it right" as well as many chances to overlook a small aspect within the design that will plague the mine throughout all levels and through the entirety of its operating life. Tim Miller (East Fairfield Coal Company) presented "Evaluation of Stress Control Layout at the Subtropolis Mine, Petersburg, Ohio." The presentation reviewed a history of instability problems associated with excessive concentrations of lateral stress at the mine site. Mr. Miller demonstrated that mine headings developed parallel to the primary horizontal stress direction exhibit the least amount of stress-related failures. Subsequently, in February 2018, the Subtropolis mine layout was turned to drive headings directly into the direction of principal lateral stress. Mr. Miller then presented visually observed and monitored strata conditions to changing geologic and mining conditions. Monitoring was performed using 3D Dynamic LiDAR scans to evaluate the effectiveness of the new mine layout. Mr. Reece Kurre (Stantec) ended the session with "A Case Study on the Efficacy of Different Roof Bolting Schemes in Lhoist North America's Crab Orchard Mine." Mr. Kurre gave an overview of Lhoist North America's Crab Orchard Mine, which uses mechanically anchored roof bolts for ground support. The mine currently uses two different roof bolting patterns, determined primarily by whether or not hazardous conditions are identified. Mr. Kurre's objective was to evaluate the relative effectiveness of each bolting pattern through numerical modeling to improve mine efficiency without compromising worker safety.

A number of the papers, including the ones discussed above from the 38th International Conference on Ground Control in Mining, are included in this special issue of the International Journal of Mining Science and Technology. All other papers from this year's conference (and conferences from previous years) can be found on the ICGCM website (http://groundcontrolmining.com/) and at OneMine (http://www.onemine.org/). We hope this special issue will provide useful references for engineers worldwide and for researchers and scholars in the field of ground control.

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