

DEEP MINING 2019 CONFERENCE

NINTH INTERNATIONAL CONFERENCE ON DEEP AND HIGH STRESS MINING

SYMPOSIUM SERIES S98



24–25 JUNE 2019

MISTY HILLS CONFERENCE CENTRE, MULDERSDRIFT
JOHANNESBURG, SOUTH AFRICA



SAIMM
THE SOUTHERN AFRICAN INSTITUTE
OF MINING AND METALLURGY



**THE SOUTHERN AFRICAN INSTITUTE OF MINING AND METALLURGY
JOHANNESBURG 2019**

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The papers in this volume have been for the most part prepared from Word documents supplied by the authors, with additional typesetting and formatting by The Southern African Institute of Mining and Metallurgy.

In order to deliver quality conference proceedings, all the published papers were independently peer-reviewed by experts in the respective specialist fields in order to ensure the highest relevance and quality.

The Organising Committee expresses its deep appreciation for the voluntary contributions of the technical review panel, listed below, in assisting to maintain high technical standards for the papers presented at this conference.

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FOREWORD

It is a great pleasure to introduce the Proceedings of Ninth International Conference on Deep and High Stress Mining (Deep Mining 2019) held at the Misty Hills Conference Centre, Muldersdrift, Johannesburg on 24 and 26 June 2019. Conferences in this series have previously been hosted in Australia, South Africa, Canada, and Chile. This Symposium was jointly organised by the South African National Institute of Rock Engineering (SANIRE), the Australian Centre for Geomechanics (ACG) and the Southern African Institute of Mining and Metallurgy (SAIMM).

Around the world, mines are getting deeper and the challenges of stress damage, squeezing ground, and rockbursts are ever-present and increasing. Mining methods and support systems have evolved slowly to improve the management of excavation damage and safety of personnel, but damage still occurs and personnel are injured. Techniques for modelling and monitoring have been adapted and enhanced to help understand rock mass behaviour under high stress. Many efficacious and dynamic support products have been developed, but our understanding of the demand and capacity of support systems remains uncertain. The Deep Mining series of conferences continues to contribute to our understanding.

Of the 33 papers included in the proceedings, 13 are from South Africa, 12 are from Australia and the remaining 24 papers are from 15 countries (Austria, Brazil, Canada, Chile, Germany, Indonesia, Israel, Japan, Namibia, Norway, Spain, Sweden, Switzerland, United Kingdom and the USA).

We are grateful to the presenters and delegates for taking time out of their busy schedules to come and share their knowledge and expertise. The sponsors are also thanked for their generous contributions and thanks are due to the organising committee and technical reviewers. As always, we are grateful for the dedication and organisational skills of the SAIMM secretariat.

William Joughin
Editor

Australian Centre for Geomechanics

The Australian Centre for Geomechanics (ACG) was formally established in 1992 as a University of Western Australia research centre in order to promote research excellence and continuing education in geomechanics, with particular emphasis on its application to the mineral and energy extraction sections of Australia's resources industry.

The Australian Centre for Geomechanics is an unincorporated Joint Venture involving:

- CSIRO Mineral Resources
- The University of Western Australia — Civil, Environmental and Mining Engineering

The ACG draws together staff knowledge, experiences and expertise from within the two groups forming the Centre and facilitates a multi-disciplinary approach to research and education in geomechanics. Research undertaken by the ACG attracts both national and global support and the outcomes of the projects are utilised to promote safer mining and environmental geomechanics practices, operating efficiencies and to meeting community expectations for sustainable mining practices.

With the guidance of strong industry representation on the Board of Management, and close collaboration with senior representatives of the mining industry, research, training and further education activities are tailored directly to the needs of industry. The ACG Board expects the Australian Centre for Geomechanics to be the focal point for industry on geomechanics issues and to address the needs of industry through a collaborative interdisciplinary approach.

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Accessing geomechanical excellence

Since 2005, the ACG has published conference papers across the geotechnical mining spectrum, including: underground and open pit mining, paste and thickened tailings and mine closure. To make many of these papers more accessible for industry and academia, the ACG launched the Online Repository of Conference Proceedings in 2017. This repository aims to provide the mining geomechanics fraternity with open access, peer-reviewed conference papers that may assist readers to maintain and develop their skills, knowledge and capabilities.

Aside from allowing users to freely download many past and current conference papers, the site features many useful functions. This highly interactive and searchable repository provides importable citation information in various formats, links to the paper authors' profiles on ORCID, ResearchGate and LinkedIn, as well as the ability to share papers on social media.

The Ninth International Conference on Deep and High Stress Mining papers are available on the repository.



Setting a high standard for technology transfer and accessibility, this valuable online resource will continue to develop and grow with future ACG geomechanical mining events.

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