



Mineral Exploitation toward Sustainability
适应可持续发展的矿产资源开发利用

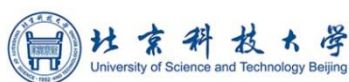
8th International Conference on Sustainable Development
in the Minerals Industry (SDIMI 2017)

June 26 - 28, 2017, Beijing, China

第八届矿业可持续发展国际会议

中国北京 2017 年 6 月 26 日至 28 日

Organized by / 主办



中国矿业大学 (北京)
China University of Mining & Technology, Beijing



辽宁工程技术大学
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GUIDE & FINAL PROGRAM / 指南及日程



<http://sdimi2017.ustb.edu.cn>

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Xijiao Hotel, No 18 Wang Zhuang Road, Hai Dian District, Beijing, China

Phone: +86 10 62322288 or Ms. Amy Xin MA: +86 13811514410 (mobile)

/北京海淀区王庄路18号, 电话: 010-62322288, 马昕女士: 13811514410

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Hotel Room Service Center: 3100 / 宾客服务中心

Hotel Reception Desk: 5608, 5609 / 总台

Emergency/应急

Venue Hotel Manager Assistant - Security: +13911483852 / 大堂副理

Metropolitan Police: +110 / 匪警

Metropolitan Fire: +119 / 火警

Metropolitan Ambulance: +120; Red Cross Ambulance: +999 / 急救

Directory Assistance/查号台

+114

Currency and Onsite Payment/货币与支付

Hotel room charges can be paid in cash of the Chinese currency (CNY/RMB/¥) or by credit card of international brands, such as American Express, MasterCard, Visa, JCB or UnionPay.

Conference registration fee is payable (to University of Science and Technology Beijing) onsite in Chinese cash only at CNY3900, 3300, 1800 or 1000, depending upon your registration category as shown on SDIMI 2017 website.

/现场注册费率为3900、3300、1800或1000元, 依注册类别而定。

Currency exchange service is available at the hotel reception desk at the current rate of Bank of China or at bank outlets within 10 min walk around the venue hotel.

Airport Transportation to/from Venue / 交通

The venue hotel is 32 km away from Beijing Capital International Airport (T3). The most convenient way is by taxi and it takes about 40-50 min at around CNY100-130 one way under normal traffic conditions during daytime and 20% more at night from 23:00pm to 5:00am.

Subway lines are also available within a 5 or 10 min walking distance around the hotel with at least 1 or up to 3 transfers (See Beijing Subway Lines with Venue).

Climate and Dress Code / 气候与着装

Temperatures in Beijing range from 20 degrees Celsius low at night to 32 degrees high during daytime in late June.

The recommended conference attire is business casual, or suites and ties for the men and dresses for the ladies. Meeting rooms are mildly air-conditioned.

/会场与会餐着装：商务休闲装或正装。

Café / 咖啡厅

Coffee service is available at the ground floor of venue hotel Building No 9. A cozy restaurant of Japanese cuisine is located on the second floor of venue hotel Building No 8.

Maan Caffee, an emerging popular Chinese brand and chain of coffeehouses, is available at Tsinghua Tongfang Hi-Tech Plaza Tower D (No 15 Wang Zhuang Road), 5 min walk toward north or on your right hand side out of the venue hotel gate.

Other café or restaurants of Japanese and Korean cuisines can be found on the fourth floor of Qing Yan Building (catering building) on the campus of the Beijing Language and Culture University, adjacent to the venue hotel and apart by two walls with pedestrian exits (See the Venue Building Layout map).

第八届矿业可持续发展国际会议地理位置图

SDIMI 2017 Conference Venue Map



第八届矿业可持续发展国际会议地铁线路图
SDIMI 2017 Conference Venue Subway Lines (Not to Scale)

北京地铁线路图

Beijing Subway Map

- 图例:**
Legend
- 地铁1号线
 - 地铁八通线
 - 地铁4号线
 - 地铁大兴线
 - 地铁6号线
 - 地铁8号线
 - 地铁10号线
 - 地铁14号线
 - 地铁房山线
 - 地铁亦庄线
 - 地铁2号线
 - 地铁5号线
 - 地铁7号线
 - 地铁9号线
 - 地铁13号线
 - 地铁15号线
 - 地铁昌平线
 - 机场线
- 换乘站



1 北京首都国际机场
Beijing Capital International Airport

2 北京西郊宾馆
XIJIAO HOTEL
BEIJING

3 北京科技大学
University of Science and Technology Beijing

4 中国矿业大学(北京)
China University of Mining & Technology (Beijing)

5 颐和园 (Yi He Yuan)
Summer Palace

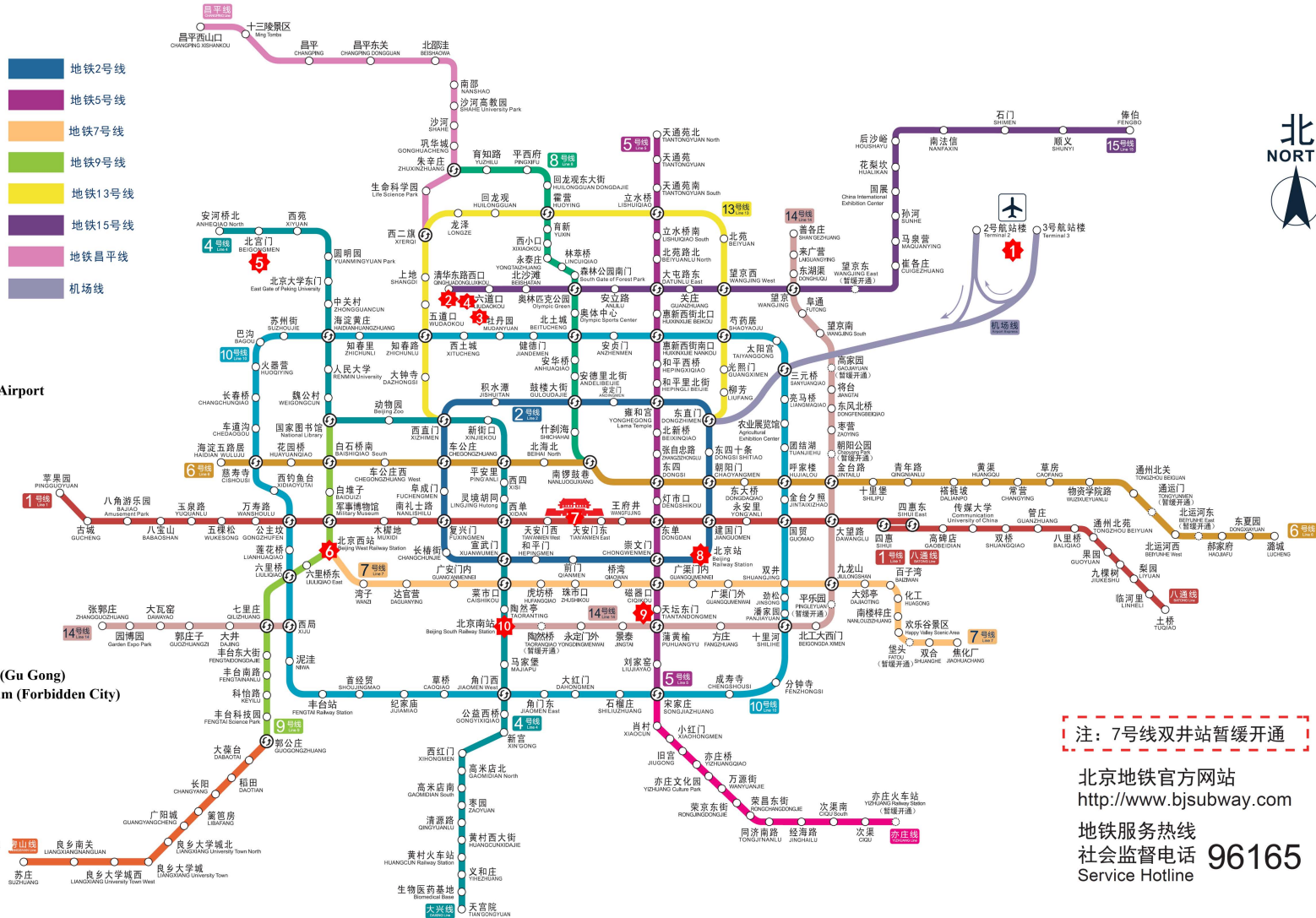
6 北京西站 (Beijing Xi Zhan)
Beijing West Railway Station

7 天安门 (Tian An Men) 与故宫 (Gu Gong)
Tiananmen and Palace Museum (Forbidden City)

8 北京站 (Beijing Zhan)
Beijing Railway Station

9 天坛 (Tian Tan)
Temple of Heaven

10 北京南站 (Beijing Nan Zhan)
Beijing South Railway Station

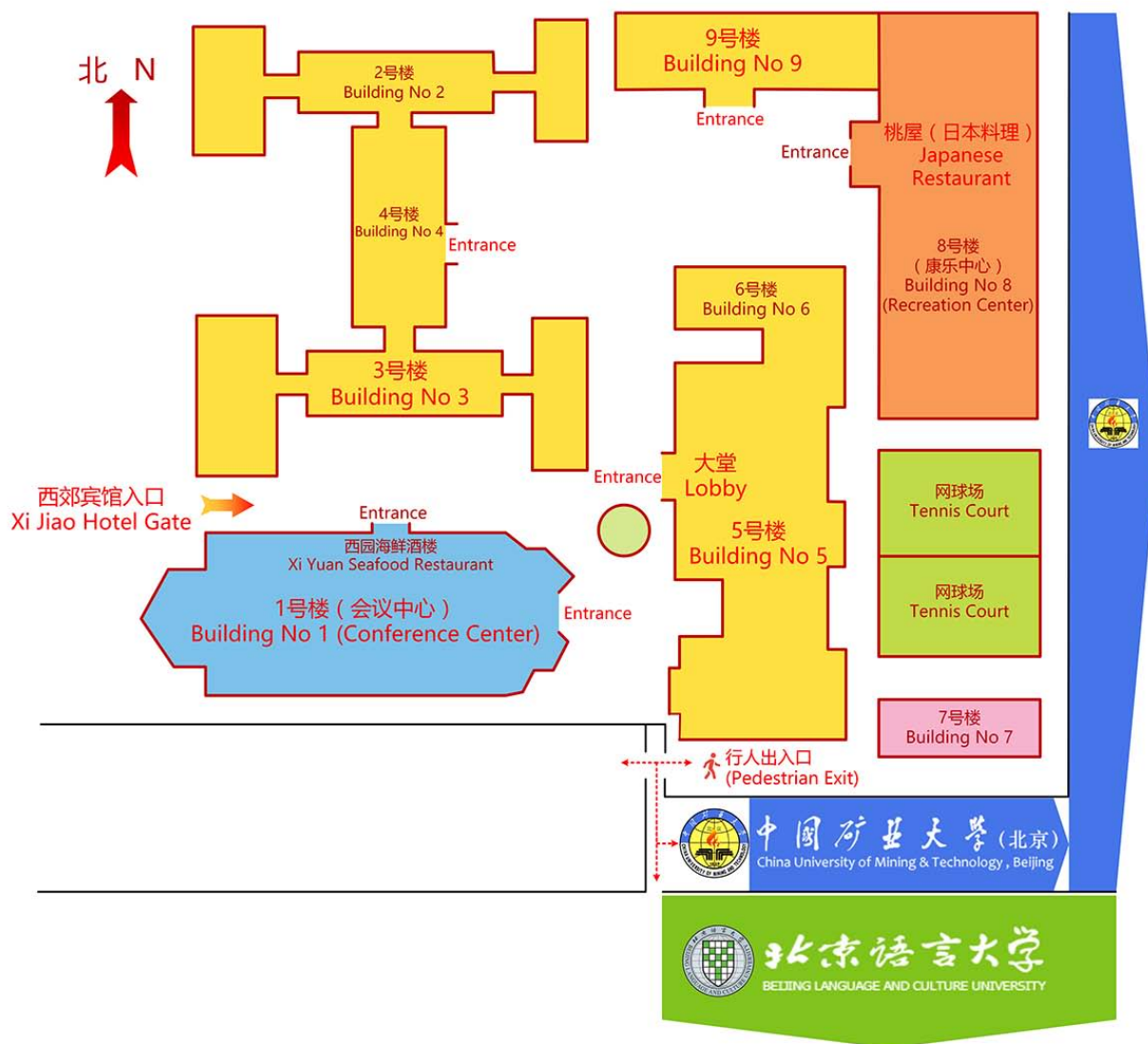


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Service Hotline

Venue Buildings Layout / 会址楼宇布局



Technical Programs / 学术日程

Day 1	PM	Sunday, June 25, 2017	Location
16:00-22:00	-	Registration and Help Desk / 注册、咨询	F 1, Bldg 5 5号楼一层
18:00-20:00	-	Reception dinner / 自助晚餐	F 1, Bldg 5, Jing Yuan 5号楼一层景园
Day 2	AM	Monday, June 26, 2017	Location
07:00-08:00	-	Buffet breakfast with coupon / 自助早餐（凭券）	F 2, Bldg 5, Shang Yuan 5号楼二层赏园
Session I	AM	Opening and Keynote Speeches, Chairing by WU Aixiang, USTB / 吴爱祥, 北京科技大学 (in English or Chinese with simultaneous interpreters and earphones)	Ginkgo Hall F 3, Bldg 1 1号楼三层 银杏大厅
08:30-08:35	I-1	Welcome and Opening Remarks by WU Aixiang, Vice President, USTB / 欢迎辞并开幕词, 吴爱祥 副校长, 北京科技大学	
08:35-08:45	I-2	Government and Sustainability in the Minerals Industry by Fu YANG, Deputy Director, SACMS / 政府部门与矿业可持续发展, 杨富 副局长, 国家煤矿安全监察局	
08:45-09:15	I-3	Sustainability Strategies for Metal Mines by Meifeng CAI, Academician, USTB / 金属矿开采可持续发展战略研究, 蔡美峰 院士, 北京科技大学	
09:15-09:45	I-4	The Present Situation of Iron Ore Resource Exploitation and Sustainability Strategies in China by Anlin SHAO, Deputy CEO, ANSTEEL / 钢铁产业与可持续发展, 邵安林 副总经理、院士, 鞍山钢铁集团	
09:45-10:05	I-5	Sustainability Strategies to Secure Raw Materials and Fuel Supply for Chinese Steel Industry by Xinchuang LI, President, MPI / 中国钢铁行业原燃料保障可持续发展战略, 李新创 院长, 冶金工业规划研究院	
10:05-10:35	-	Photo Taking / 合影; Coffee Break / 茶歇	F 3, Bldg 1 1号楼三层
	-	Registration and Help Desk / 注册、咨询	
Session II	AM	Invited Speeches, Chairing by WANG Jiachen, CUMTB / 王家臣, 中国矿业大学(北京) (in English or Chinese with simultaneous interpreters and earphones)	Ginkgo Hall F 3, Bldg 1 1号楼三层 银杏大厅
10:35-11:00	II-1	Deep Amalgamation of Security Risks - a Sustainability Perspective by Xingkai ZHANG, President, CASST / 安全风险深度融合与矿业可持续发展, 张兴凯 院长, 中国安全生产科学研究院	
11:00-11:25	II-2	Paths toward Sustainability with the Minerals Industry in China by Xin'an ZHANG, President, CALRE / 中国矿业可持续发展的路径选择, 张新安 院长, 中国国土资源经济研究院	
11:25-11:55	II-3	Green Mine Development Practices toward Sustainability by Gang HE, President, Guizhou Kailin / 矿山绿色可持续开发模式研究与实践, 何刚 董事长, 贵州开磷控股集团	
12:00-13:00	-	Buffet lunch with coupon / 自助午餐（凭券）	F 2, Bldg 5, Shang Yuan 5号楼二层赏园

Session III	PM	Invited Speeches, Chairing by SHAO Liangshan, LNTU / 邵良杉, 辽宁工程技术大学 (in English or Chinese with simultaneous interpreters and earphones)	
13:30-13:50	III-1	The Present Situation and Future Perspective of Gold Mining Industry in China by Yongtao ZHANG, Vice President, CGA / 中国黄金行业发展现状及未来展望, 张永涛 副会长, 中国黄金协会	
13:50-14:10	III-2	Cyclic Economy and Sustainability - Experiences with Coal Mines by Bin YU, Chief Engineer, Datong Coal Mine / 煤炭企业发展循环经济的探索与实践, 于斌 总工程师, 同煤集团	
14:10-14:30	III-3	Sustainability from Concept to Practice in Mining Industry by Ye ZHANG, Director, China Minmetals / 矿业可持续发展理论与实践, 张晔 主任, 中国五矿集团	Ginkgo Hall F 3, Bldg 1 1 号楼三层 银杏大厅
14:30-14:50	III-4	Influence of Social-Economic Development on Safety Production in China by Xueqiu HE, Professor, USTB / 中国经济社会发展对安全生产影响规律研究, 何学秋 教授, 北京科技大学	
14:50-15:10	III-5	Sustainable Development throughout the Mining Life Cycle by Dirk van ZYL, Professor, UBC / 贯穿采矿生命周期之可持续发展, 德克·范泽尔 教授, 加拿大不列颠哥伦比亚大学	
15:10-15:30	III-6	Modern Mineral, Energy and the Environment by Fun-Den WANG, Professor, CSM / 现代矿产、能源与环境, 王逢旦 教授, 美国科罗拉多矿业学院	
15:30-15:50	-	Coffee Break / 茶歇	
Session IV	PM	Mineral Resources for Sustainability, Co-Chairing by Lianjun GUO and Jinke LI (in English only)	
15:50-16:10	IV-1	Blue Mining - Today's Mine Planning for Future Mines by Oliver LANGEFELD	Ginkgo Hall F 3, Bldg 1 1 号楼三层 银杏大厅
16:10-16:30	IV-2	Coal Mine Based Circular Economy Park: A Case Study by Zhen WEI	
16:30-16:50	IV-3	Macroeconomic and Political Determinants of Resource Nationalism by Wenhua LI	
16:50-17:10	IV-4	Optimization of Cut-Off Grades for Molybdenum and Tungsten Open-Pit Mines by Qinghua GU	
17:10-17:30	IV-5	Strategies for Highly-Efficient Recovery of Coal Resources in China by Yanghui REN	
17:30-17:50	IV-6	Analysis and Improvement of Mineral Resources Sustainability by Juntao WANG	
18:00-19:30	-	Conference banquet / 晚餐	Dong Yuan F 1, Bldg 5 5 号楼一层东园

Day 3	AM	Tuesday, June 27, 2017	Location
07:00-08:00	-	Buffet breakfast with coupon / 自助早餐 (凭券)	Shang Yuan F 2, Bldg 5 5号楼二层赏园
Session V	AM	Mineral Resources for Sustainability, Co-Chairing by Oliver LANGEFELD and Zhongxue LI (in English only)	Jinyuan Hall F 2, Bldg 5 5号楼二层 金缘厅
08:00-08:20	V-1	Is it time for a Global Mining Initiative 2.0 by Michael TOST	
08:20-08:40	V-2	Optimal Utilization of Low Grade Ores in Anqian Mining Company by Lihua LUAN	
08:40-09:00	V-3	Considerations Regarding Sustainable Development in the Vietnamese Coal Mining Industry by Naoko SHIMAZAKI	
09:00-09:20	V-4	Production Scheduling of Open Pit Metal Mine with Ecological Cost by Xiaochuan XU	
09:20-09:40	V-5	Zinc and Copper Recovery from Smelter Waste Stream Case Study by Frank SU	
09:40-10:00	V-6	The Impact of Structure Change on Copper Prices by Kegomoditswe KOITSIWE	
10:00-10:20	V-7	An Expert System for Metal Resources Exploration and Mining Feasibility Evaluation by Jianhong CHEN	
10:20-10:40	-	Coffee Break / 茶歇	F 2, Bldg 5 5号楼二层
	-	Help Desk and Registration / 咨询、注册	
Session VI	AM	Mine Safety, Risk and Sustainability, Co-Chairing by Xueqiu HE and Michael TOST (in English only)	Jinyuan Hall F 2, Bldg 5 5号楼二层 金缘厅
10:40-11:00	VI-1	Data Management Best Practices of Complex Socio-technical Systems: A Review of U.S. Mining Safety and Health Management by W. Pratt ROGERS	
11:00-11:20	VI-2	Fuzzy Reliability Based Bow Tie Analysis of Coal Mine Water Inrush Risks by Cong ZHANG	
11:20-11:40	VI-3	Tailings Pond Life Cycle Safety Management System by Quanming LI	
11:40-12:00	VI-4	Complex Network Model for Characterizing Hazards and Risks Associated with Mine Tailings Facility by Zhixin ZHEN	
12:00-12:20	VI-5	Surfactant-Magnetized Water for Coal Dust Prevention by Botao QIN	
12:20-13:00	-	Buffet lunch with coupon / 自助午餐 (凭券)	Shang Yuan F 2, Bldg 5 5号楼二层赏园

Session VII	PM	Mine Environment and Sustainability, Co-Chairing by Bernhard KLEIN and Andre XAVIER (in English only)	
13:30-13:50	VII-1	Sustainable Water Management: Implications for Mining in Environmentally Sensitive Areas by Harmony MUSIYARIRA	Jinyuan Hall F 2, Bldg 5 5 号楼二层 金缘厅
13:50-14:10	VII-2	Adsorption-Coagulation Mechanism of Composites in Treating Acid Mine Drainage by Liping XIAO	
14:10-14:30	VII-3	Pathways to Shrink CO2 Emissions in China's Coal Industry by Jinke LI	
14:30-14:50	VII-4	A Review on Integrated Mineral Carbonation Process in Ultramafic Mine Deposit by Jiajie LI	
14:50-15:10	VII-5	Comprehensive Utilization of Water in Underground Metal Mine by Song JIANG	
15:10-15:30	VII-6	Bibliometric Overview on Energy-Water Nexus Research in Chinese Literature by Jingli FAN	
15:30-15:50	VII-7	Mine Water Storage in Gobs for Sustainability by Beifang WANG	
15:50-16:10	-	Coffee Break / 茶歇	F 2, Bldg 5 5 号楼二层
Session VIII	PM	Mining Development and Communities, Co-Chairing by Dirk van ZYL and Guoqing LI (in English only)	
16:10-16:30	VIII-1	The Role of Participatory Environmental Monitoring Committees in Mining Regions in Peru by Andre XAVIER	Jinyuan Hall F 2, Bldg 5 5 号楼二层 金缘厅
16:30-16:50	VIII-2	Wetbud - A Free Water Budget Modeling Tool for Created Wetland Design by Zach AGIOUTANTIS	
16:50-17:10	VIII-3	Public Engagement and Sustainable Energy Development by Ellen GILLILAND	
17:10-17:30	VIII-4	Interventions for Ensuring the Sustainability of the Small Scale Mining Sector in Namibia by Harmony MUSIYARIRA	
17:30-17:50	VIII-5	Contributions of Artisanal and Small-Scale Mining to Sustainability through Building Capacity of Mining Communities by Gustavo Adolfo ARISTIZÁBAL-H	
18:00-19:00	-	Buffet dinner with coupon / 自助晚餐 (凭券)	Shang Yuan F 2, Bldg 5 5 号楼二层赏园

Day 4	AM	Wednesday, June 28, 2017	Location
07:00-08:00	-	Buffet breakfast with coupon / 自助早餐 (凭券)	Shang Yuan F 2, Bldg 5 5 号楼二层赏园
Session IX	AM	Technology and Capacity Building for Sustainability, Co-Chairing by Steve ZOU and Harmony MUSIYARIRA (in English only)	
08:00-08:20	IX-1	Investigation of the Effect of Drill Bit Rotation Speed on Sustainable Drilling by Niyazi BİLİM	Jinyuan Hall F 2, Bldg 5 5 号楼二层 金缘厅
08:20-08:40	IX-2	Control Mechanism and Support Technology of Soft Coal Roadway in the Fully Mechanized Mining Work Face by Genshui WU	
08:40-09:00	IX-3	Abrasion Properties of Some Building Stone Wastes and Usability for Sustainability by Bilgehan KEKEÇ	
09:00-09:20	IX-4	Application of Three-Dimensional Geological Modelling in Coal Mining by Liyan REN	
09:20-09:40	IX-5	Design and Analysis of a Kind of Centralized Forced Flip-Flow Screen by Zhenqian WANG	
09:40-10:00	IX-6	Preparation of High Purity Manganese Sulphate from Low-Grade Rhodochrosite by Fang LIAN	
10:00-10:20	IX-7	Flow Behaviors in a Cyclonic-Static Micro-Bubble Flotation Column by Xiaokang YAN	
10:20-10:40	-	Coffee Break / 茶歇	F 2, Bldg 5 5 号楼二层
	-	Help Desk and Registration / 咨询、注册	
Session X	AM	Social Responsibility and Sustainability, Co-Chairing by Zach AGIOUTANTIS and Michael HITCH (in English only)	
10:40-11:00	X-1	Emergence of Differential Social License: A Case of Impact and Benefit Agreements in Nunavut, Canada by Michael HITCH	Jinyuan Hall F 2, Bldg 5 5 号楼二层 金缘厅
11:00-11:20	X-2	Sustainable Mining - a Case Study in Canadian Practice by Steve ZOU and Cui LIN	
11:20-11:40	X-3	Children's Experiences of the Coal Mine Disaster: Analysis of Junior High School Students' Essays in Yubari City by Ryota KASAHARA	
11:40-12:00	X-4	Evaluation of the Senior Coal Mine Managers' Working Stress by Qi HE	
12:00-12:10	X-5	Introduction to SDIMI 2019 in Sydney by Michael HITCH at UNSW	
12:10-12:50	-	Buffet lunch with coupon / 自助午餐 (凭券) SDIMI 2017 closed / 会议结束	Shang Yuan F 2, Bldg 5 5 号楼二层赏园
12:30-18:00	PM	Half-day cultural excursion immediately after lunch on Wednesday, June 28, 2017 to the Badaling Great Wall in Beijing suburb, 80km away from downtown. Admission/entrance ticket is self-paid with free transportation. Pre-registration is required.	To set off at 12:30 PM from the roundabout or circle in the hotel courtyard.
Day 5	-	Thursday, June 29, 2017	Free

Welcome and Opening Remarks / 欢迎辞、开幕词

WU Aixiang

Vice President, University of Science and Technology Beijing (USTB)
Co-Chairman, National Steering Committee, SDIMI 2017

The Honorable Mr. YANG, Mr. CAI, Mr. SHAO, Colleagues, Distinguished Participants, Ladies and Gentlemen:

I welcome you all to Beijing for this meeting titled “The 8th International Conference on Sustainable Development in the Minerals Industry” (SDIMI 2017).

As stated in our program, the objective of the conference is to assist the global minerals industries in their transition to sustainable development by providing all the participants with an international forum to discuss and share experiences and best practices on the theme Adapting Mineral Exploitation to Sustainability for Safety, Health, Environment and Community.

Sustainability is not just a modern buzzword but a traditional ideology which can be traced back to the world's earliest civilizations. In such a long journey of sustainability, mining, minerals and metals are important to the economic and social development of many countries and minerals are essential for modern living.

It is with the above background in mind that the conference organizers decided to bring together international expertise and scholars in order for them to discuss technologies and mechanisms, share experiences and best practices, and build common capacity on the adaptation of mineral exploitation to sustainability for safety, health, environment and community under the new normal conditions and circumstances.

The conference sessions will highlight the practice and understanding of sustainability in the minerals industry while promoting sustainable mineral exploitation to ensure safe and healthy working environments as well as community stewardship especially within emerging economies and under the new normal.

Our invited speakers, specialists and participants have come from nearly 20 countries or regions and will give more than 50 presentations, providing not only a wealth of knowledge, but also a variety of subjects and understandings. We appreciate your interest and contributions without which this conference would never have been possible.

We would also like to recognize all our supporting and sponsoring institutions, including National Natural Science Foundation of China, China Coal Society, China Gold Association, China Nonferrous Metal Mining (Group), China National Gold Group, Shandong Gold Group, Guizhou Kailin Holdings (Group), which have helped make our conference even greater. I thank you all for your support or sponsorship and taking time from your busy schedules to come and contribute to this conference.

Last but certainly not least, I thank the Executive Council of Co-Chairs, Secretariat, volunteers, interpreters, and our conference venue Xijiao Hotel for their great job and accomplishments in bringing us here.

With those remarks, I declare this conference open and wish you all fruitful deliberations.

欢迎辞、开幕词

北京科技大学副校长、指委会主席 吴爱祥

尊敬的杨局长、蔡院士、邵院士、合作/兄弟单位领导，各位嘉宾、代表、女士们、先生们：

我代表本次会议主办单位及组委会热烈欢迎各位莅临“第八届矿业可持续发展国际会议”指导及参会。

正如会议日程所言，本次国际会议的目的是为与会代表提供一个国际论坛，研讨和分享有关矿业可持续发展的理论、经验与最佳实践，进而促进全球矿业向可持续发展转型。

可持续发展不单是一个流行术语，更是一种内容丰富的思想体系和持续改善的动态过程。在此人类文明进程中，矿产资源开发利用发挥了、正在发挥着、而且还将继续发挥重要的作用，对人类现代生活必不可少。

铭记于心，本次会议合作单位，各尽所长、精诚合作，汇聚全球专家学者研讨矿业可持续发展相关机制与技术，分享经验与实践、建设能力与水平，借以促进新常态条件下矿产资源开发利用及可持续发展。

本会的后续单元中，专家代表将会聚焦有关矿业可持续发展的认识与实践，以期使矿产资源开发利用的机制与技术能够确保生产安全、职业健康和社区发展，对于新经济体尤需如此。

来自近 20 个国家、地区的约 200 余名特邀专家、学者、代表、嘉宾与会，拟做 50 余篇学术报告，不仅可以分享经验、凝聚共识，也会带来多样的可持续发展议题、理解与认知。我们衷心感谢专家学者对本次会议的贡献，没有你们的积极参与，本次会议无从谈起。

我也借此机会，代表会议主办单位，高度赞赏本次会议的协办和支持单位，包括国家自然科学基金会、中国煤炭学会、中国黄金协会、中国有色矿业集团、中国黄金集团、山东黄金集团、贵州开磷集团等，为我们的国际会议创造了优良的条件。谢谢你们鼎力支持与拨冗参会。

同样，我要感谢会议的执委会、秘书处、志愿者、翻译以及西郊宾馆工作人员等为筹备本次会议所做的辛勤、有效的付出。

借此，我宣布第八届矿业可持续发展国际会议正式开幕。

Keynote Speech / 基調報告

Government and Sustainability in the Minerals Industry

YANG Fu

Deputy Director
State Administration of Coal Mine Safety (SACMS)

Distinguished Participants, Ladies and Gentlemen:

I am honored to speak to you today on such an important occasion of the opening ceremony at the 8th International Conference on Sustainable Development in the Minerals Industry. I would like to express my sincere appreciation to the conference organizers for the invitation.

It is well known that sustainable development is of concerns by people all around the world. As matter of fact, almost all of the early human civilizations and modern societies have been striving toward a healthy and productive life in harmony with nature.

Therefore, the modern science of sustainability has been shaped since the second half of 20th century while industrial massification and radical globalization were bringing significant impacts on the earth and human society. Correspondingly it is concerned with virtually all the disciplines and fields and is studied over various time and space dimensions, ranging from the total carrying capacity of planet Earth, climate change and the development of biological and human systems through national or regional governance, economic sectors and technological innovations, and even to communities and family lives in analytic or philosophical approaches.

With the rapid scientific, technological and engineering advancement and the industrial revolution, the capability of human's creation and intervention with the nature has been significantly empowered, and the expansion of human economic and social activities has become far reaching in space and omnipresent in time. Consequently, the negative impacts of human activities plus natural catastrophes on various occasions have caused human anxiety that the Earth's carrying capacity would be exceeded. Some economic, social and natural phenomena or evidence have also shown real challenges and threats to the wellbeing of human and the earth, such as natural resources depletion, environmental pollution, ecological degradation, climate change and even regional disputes and conflicts.

Those problems are so pressing that they have become global concerns and precautionary actions are needed to prevent catastrophic events and mitigate negative impacts by promoting sustainable patterns of consumption and production. This is especially true in places where the issues of resource depletion, environmental pollution and ecological degradation tend to be severe in terms of workplace safety, occupational health, industrial ecology, and regional environment.

As early as 1962, Rachel Carson's book *Silent Spring* depicted "A Fable for Tomorrow," a nameless, suburban American town where all life - from fish to birds to apple blossoms to human children - had been "silenced" by the insidious effects of DDT, which inspired the American environmental movement. This might be seen as one of the milestones in the global journey of sustainability.

The United Nations has been actively promoting the concept and implementation of global sustainability. A series of conferences organized by the United Nations, such as the UN Conference on

the Human Environment (UNCHE) in 1972, the UN Conference on Environment and Development (UNCED) in 1992, the World Summit on Sustainable Development (WSSD) in 2002 and the Conference on Sustainable Development (UNCSD) in 2012, all have provided frameworks and mechanisms for global sustainability.

The Chinese government has also made efforts to promote sustainability. In order to commit itself to the United Nations Agenda 21, China developed and adopted its National Agenda 21 in 1994 - A White Paper on China's Population, Environment and Development in the 21st Century, as a guideline for economic and social development in China. Since then, sustainability has been integrated into China's economic and social activities and implemented extensively. For example, in 2003, a human-oriented and science-based development strategy was put forward to promote sustainability by adhering to strategies for conservation, clean production and safe work environment. In 2012, promotion of ecological civilization and public health has been integrated into national economic and social development strategies, together with the developmental framework toward Innovation, Harmony, Greenness, Openness, and Sharing. In 2017 at the World Economic Forum, President Xi Jinping proposed an initiative for the world to jointly build a community of common destiny for all mankind, and launched the Belt and Road Initiative for international cooperation to promote globalization and sustainability.

Now let's get back to our theme – mineral resource development. On the one hand, the extractive industries are essential for providing raw materials for the development of human society and civilizations, as indicated and symbolized by the historical terms of stone age, iron age, bronze age, and nuclear age. On the other hand, the extraction and exploitation of mineral resources have also brought some real challenges. Due to historical, large-scale and extensive excavations and wastes disposals related to mineral exploitation, the extractive industries have indeed induced significant impacts on the environment and society, such as accumulation of massive wastes, emission of hazardous substance, occupational safety and health hazards, local geological failures, disturbance of landscape and ecological systems, and even climate change due to fossil fuel consumption.

In order to adapt sustainable development in mineral extraction and exploitation in response to social concerns worldwide, the global mining industry launched the proposal of Global Mining Initiative in 1999. Through the global project - Mining, Mineral and Sustainable Development (MMSD), a series of investigations on mining impacts and comprehensive assessments were conducted to show the relationship between the extractive industries and sustainability. As stated in the Plan of Implementation by the United Nations World Summit on Sustainable Development in 2002, “mining, minerals and metals are important to the economic and social development of many countries. Minerals are essential for modern living”. Consequently, the Extractive Industries Transparency Initiative (EITI) was proposed and has been implemented. Some other regional, national and industrial initiatives, frameworks or mechanisms on mining related sustainability have also been proposed and practiced, such as that by the International Mining and Metal Council (ICMM).

As part of the efforts by the mining professionals towards sustainability, the main objective of the series of International Conference on Sustainable Development in the Minerals Industry (SDIMI), as a global forum devoted to mining related sustainability, is to assist the global minerals industries in their transition to sustainable development. It has been 15 years since SDIMI's first conference was inaugurated in Greece in 2003 and seven conferences have been successively held in Germany,

Australia, and Canada. This eighth conference is being held in Asia and China for the first time. It is particularly significant to the region.

With the rapid growth of industries and emerging economies, mineral resources are massively extracted and consumed, and sustainability issues associated with mineral extraction and exploitation are widely concerned. To respond to the concerns and address those issues and challenges, SDIMI 2017 takes as its theme Adapting Mineral Exploitation to Sustainability for Safety, Health, Environment and Community.

I am looking forward to in-depth discussions on a wide range of topics in mineral resource exploitation, mine safety and health, community and environmental sponsorship. I sincerely hope this conference will promote implementation of sustainable mechanisms and practices in scientific research and development, technology, engineering, and industrial operations. I hope all stakeholders will take concrete actions and adapt the concept of mineral exploitation toward sustainable development for human wellbeing around the globe.

Finally, I'll take this opportunity to wish this international conference a complete success, and all participants a joyful time during the conference.

政府部门与矿业可持续发展

——“第八届矿业可持续发展国际会议”大会基调和报告

国家煤矿安全监察局副局长 杨富

各位代表、嘉宾、女士们、先生们：

值此“第八届矿业可持续发展国际会议”召开之际，有机会从政府的角度，就矿业可持续发展领域讲几句话，深感荣幸，衷心感谢大会主办单位的盛情邀请。

众所周知，可持续发展是一个世界性、全球性倍受关注的议题。我们深知，人类社会的文明进步就是表现在人们不断探索、从早期文明向富有生产成果的、安全健康的、繁荣多样的、和谐共享的无尽理想而持续发展的历程。

在学术上，可持续发展理论基本形成于上世纪中、后期，来源于人们对大规模工业化和高速全球化发展所带来的诸多负面问题的探索和认知。相应地，现代可持续发展科学，几乎涉及所有学科领域和各种时空尺度，从地球承载力、气候变化、生态及人类系统、国家治理，到产业部门、区域发展、技术创新，再到社区、家庭及个体的能力建设。

工业革命及工程技术的突飞猛进，使得人类干预自然及人工创造的能力显著增强。相应地，经济社会活动时空迅速扩大、无所不在，导致人们产生对这些活动超越地球承载能力与极限的担忧，一些科学、经济、社会现象似乎也预示或佐证着人类正在经历和面临诸多生存、发展要素巨变的挑战。譬如，资源耗竭、环境污染、生态退化、气候变化、地区争端等区域及全球性问题长期存在，对人类的生存、发展及福祉构成了巨大的威胁。

这些都迫切需要人们未雨绸缪、预防灾难性事件发生或延缓减轻灾害性事件后果。特别是就新兴发展中国家而言，似乎仍在重复着工业发达国家上世纪前半叶走过的高消耗、高污染、高投入的发展途径，生产安全形势严峻、职业病危害隐患凸显、生态环境事件多发。

早在1962年，蕾切尔·卡逊发表的惊世著作《寂静的春天》，就描述了人类可能面临一个没有莺啼、没有燕舞、没有蛙鸣的世界，唤醒了现代人对环境保护问题的特别关注，引发了现代环境保护运动的肇始，促进了全球可持续发展共识的形成。

联合国 1972 年的“人类环境大会”、1992 年的“环境与发展大会”、2002 年的“世界可持续发展峰会”、2012 年的“可持续发展大会”，为全球可持续发展提供了一系列重要的契机、活力、途径与机制框架。

中国政府高度重视经济社会可持续发展，为践行对《21 世纪议程》等联合国可持续发展文件的承诺，于 1994 年发布实施了《中国 21 世纪议程》，从我国国情出发，提出了人口、经济、社会、资源和环境相互协调、可持续发展的总体战略、对策和行动方案，将这一议程作为制订国民经济和社会发展规划的指导性文件；于 2003 年提出了以人为本、科学发展，强调坚持节约发展、坚持清洁发展、坚持安全发展，实现可持续发展；于 2012 年提出了将生态文明与全民健康建设纳入国民经济与社会发展规划，确立了“创新、和谐、绿色、开放、共享”五位一体的发展理念；2013 年习近平主席提出共建丝绸之路经济带和 21 世纪海上丝绸之路，即“一带一路”的倡议，大力弘扬“和平合作、开放包容、互学互鉴、互利共赢”为核心的丝路精神；今年，习近平主席在达沃斯论坛发表演讲，首次为世界提出了构建人类命运共同体的倡议，并组织发起“一带一路”高峰论坛及相关国际合作机制，致力于推进全球化与可持续发展。

矿业作为提供人类社会发展所必需原材料的基础产业，一直伴随着人类的进步，一些人类文明的发展阶段甚至以矿产为标志，譬如，石器时代、铁器时代、青铜器时代、核时代等等。

毋庸讳言，矿产资源的开发利用，在造福人类的同时，由于大规模、大尺度的采挖、消耗，乃至人为的控制不当，对生态环境及社会产生了重大影响，诸如废弃物及污染物排放、职业病危害、局部地质灾害诱发、自然景观及水系生态损害、温室气体及气候变化等，引发了人们的广泛关注。

为了顺应社会对矿业可持续发展问题的关注，全球矿业界于 1999 年发起了全球矿业倡议--通过“矿业、矿产和可持续发展”项目，全面评估矿业与经济社会可持续发展的关系，并于 2002 年联合国“世界可持续发展峰会”的《实施计划》中提出，矿业对多数国家的经济和社会发展都至关重要，为促进矿业可持续发展的最佳实践，倡议提出实施“采掘业透明行动计划”。此后，一些国家政府及其相关部门及国际采矿和金属理事会等产业组织，开始建立并推进诸多采掘业可持续发展机制框架。

“矿业可持续发展国际会议”，作为矿业界为全球可持续发展而努力的一个平台，自 2003 年首次在希腊举办以来，已先后在德国、澳大利亚、加拿大等国家举办了七次。本届第八次会议首度在亚洲及中国举行，具有特别重要的意义。

这是亚洲及中国经济社会发展之必需，我们深知本地区矿产资源开发利用及相关经济活动范围广、规模大，相关的职业安全与健康、生态环境、矿城转型等可持续发展问题备受关注。正是为了积极响应这些客观需求，本届“矿业可持续发展国际会议”的主题确定为：适应可持续发展的矿产资源开发利用——关注安全、健康、环境与矿城。

综上所述，我期待着通过本次会议主题及其相关问题的研讨和交流，诸如矿产资源开发利用、职业安全与健康保障、区域生态环境护理等，推进学术、产业、政府等方面采取协同行动，促进相关领域的科学研究、技术开发、能力建设，以及多方参与机制的实践，使得新兴经济区及经济体的矿产资源开发利用能够更好地适应于、保障于全球、亚洲及各国经济社会的可持续发展。

最后，借此机会，预祝本次国际会议圆满成功，与会代表嘉宾健康愉快！

Invited Speech Outlines / 特邀报告提纲

Sustainability Strategies for Metal Mines

Meifeng CAI

Professor, University of Science and Technology Beijing (USTB), China

Outline: Unavailable at the time of printing and announcing.

The Present Situation of Iron Ore Resource Exploitation and Sustainability Strategies in China

Anlin SHAO

Deputy CEO, Ansteel Group Corporation, China

Outline: The key points in the presentation are:

- (1) Iron ore resource endowment, production and supply, and technological advancement.
- (2) Achievements in environmental and social sustainability.
- (3) Reliance on overseas resource, unbalanced industrial chains, tax overburden, and low concentration.
- (4) Role of metallurgical industry in economy, and output and supply planning.
- (5) Institutional, policy and managerial issues.
- (6) Research and development and technological innovations.
- (7) Adaptation toward sustainability.

Sustainability Strategies to Secure Raw Materials and Fuel Supply for Chinese Steel Industry

Xinchuang LI

President, China Metallurgical Industry Planning and Research Institute (MPI), China

Outline: The key points in the presentation are:

- (1) Status of iron and steel industries, including metallurgical industries with the global industrial and economic transformation, Chinese iron and steel consumption and production, and industrial and market dynamics.
- (2) Demand, supply and availability of raw materials and fuels, including iron ore, coking coal, manganese ore, chromite ore, and nickel ore.
- (3) Sustainability strategies in perspective.

Deep Amalgamation of Security Risks - a Sustainability Perspective

Xingkai ZHANG

President and Professor, China Academy of Safety Science and Technology (CASST), China

Outline: The key points in the presentation are:

- (1) Deep amalgamation of security risks, including current security problems and issues, safety technologies, examples for risk amalgamation, and stages and characteristics for security risk management.
- (2) Impacts of security risk amalgamation on sustainability, including high frequency of safety

incidents/events, enormous costs from human hazards, and social costs by incidents/events.

(3) Strategies and tactics for sustainability in terms of security, including not-in-my-back-yard concerns and corporate social responsibility, innovations for supporting sustainability, and building capacity for preventing and mitigating risks toward sustainability.

Paths toward Sustainability with the Minerals Industry in China

Xin'an ZHANG

President and Research Professor, Chinese Academy of Land and Resource Economics (CALRE), China

Outline: The key points in the presentation are:

(1) Current situations with the Chinese minerals industry, including over production, lack of elasticity, out of balance, production concentrated in environmentally sensitive regions, ecological losses, unbalanced profit sharing, low utilization and efficiency, and impact of new resourcing.

(2) Goals of the Chinese minerals industry toward the year of 2030, including energy independency, turning point with consumption, zero release or emission, and industrial upgrading by resource innovation.

(3) Strategies for the Chinese minerals industry toward sustainability, including supply-side structural reform, industrial upgrading and transformation, mineral resource availability and conservation, green mine building, improvement of mineral rights and royalty mechanisms, assessment of resource utilization and efficiency, and resource innovation.

Green Mine Development Practices toward Sustainability

Gang HE

President, Guizhou Kailin Holdings (Group), China

Outline: Unavailable at the time of printing and announcing.

The Present Situation and Future Perspective of Gold Mining Industry in China

Yongtao ZHANG

Vice President, China Gold Association (CGA), China

Outline: Unavailable at the time of printing and announcing.

Cyclic Economy and Sustainability - Experiences with Coal Mines

Bin YU

Chief Engineer, Datong Coal Mine Group, China

Outline: The key points in the presentation are:

(1) Background on the circular economy park at TASHAN, Datong Coal Mine Group, including the project, thoughts and strategies, principles and goals, and industrial chains.

(2) Technologies to support the development of circular economy park at TASHAN, including highly efficient mining systems to achieve a coal production capacity of 10 million tonnes annually; comprehensive mining, separation and processing of coal and kaolinite; water saving, energy conservation and emission reduction systems.

- (3) Performance of the circular economy park, including targets, features and outlook.

Sustainability from Concept to Practice in Mining Industry

Ye ZHANG

Director of the Board Office, China Minmetals Corporation, China

Outline: The key points in the presentation are:

- (1) Sustainability concepts, including Chinese ancient philosophies, sustainability in modern times, and UN initiatives and mechanisms
- (2) Implications of sustainability to the minerals industry, including importance of minerals industry to economy, mining as basis for the development of many countries, concerns with mining, and the future of mining.
- (3) Analytic framework of sustainability in terms of minerals industry, including major initiatives and guidelines, minerals industry toward sustainability, and a case study.
- (4) Sustainability practices by Minmetals, including sustainability management systems, corporate social responsibility, and outlook.

Influence of Social-Economic Development on Safety Production in China

Xueqiu HE

Professor, University of Science and Technology Beijing (USTB), China

Outline: Entering the 21st century, industrial disasters frequently occur in China. The situation is severe. Industrial safety is closely related to economic growth. Going after economic growth, safety development as well as sustainable development has become our social primary purpose. At present, China is in the key historical period of transforming economic structure and changing economic growth mode. As an important constituent part of the economy and society, work safety is undergoing profound changes and exhibits the special regularity.

This work first analyzed the basic features of the influence of China economic growth on work safety. On this basis, social-technical methods of safety development were proposed. It was pointed out that economic structure and economic cycle affect work safety, displaying significant “structural effect” and “economic cycle driven” signs. The second industry is the key structural influencing factor of industrial safety. The prevention and control of industrial accidents is dependent on the technical progress. The change of economic system may break the balance of social factors and technological factors, leading to the increase of work safety risk. In the process of economic system reform, enterprises should strengthen monitoring work safety risk and effectively resolve negative impacts on the workplace safety. The risk control of work safety is not only a technical problem, but also a social and economic problem. It is inevitable to seek a set of comprehensive treatment composed by technical, social and economic factors. The coordination of work safety and economic growth must be dealt with massive public policies at macro level. Nowadays in China, economic growth rate decreases from high speed to middle - high speed. The pattern of economic development is transformed from extensive growth to intensive growth, and economic development power changes from factor-driving to innovation-driven. These major changes in economy field, on the one hand, have increased unstable factors, and on the other hand, provide historical opportunity for the development of industrial safety.

Sustainable Development throughout the Mining Life Cycle

Dirk van ZYL

Professor, University of British Columbia (UBC), Canada

Outline: Unavailable at the time of printing and announcing.

Modern Mineral, Energy and the Environment

Fun-Den WANG

Professor Emeritus, Colorado School of Mines (CSM), USA

Outline: The responsibility, mission and harmony by industry are to provide an ample supply of resources with affordable economics in a safe and healthy environment. The key points in the presentation are:

(1) From waste to wealth: using advanced technology; automation, milling, expanding resources; research to turn waste into potential valuable assets.

(2) Advanced Technology: To enhance the acceleration of the recovery of all resources, advanced technology can be used to help meet the environment and health conditions.

(3) Automation: Strengthening mechanization, automation and remote control can improve economics and operational safety.

(4) Milling: Adopting and developing particle separation technology can be utilized for better recovery of valuables at a more efficient and lower cost.

(5) Expanding Resources: Through the use of the above methods and other technologies applied to thinner, narrower, leaner and irregular deposits, we can increase our resources and recoverable reserves more than severable times with better economics.

(6) Research, Development and Funding: Emphasizing research and development in minerals and energy as well as in conjunction with recovery operations will be beneficial for the industry.

Technical Paper Abstracts / 学术论文摘要

Mineral Resources for Sustainability (A)

Blue Mining - Today's Mine Planning for Future Mines

Oliver Langefeld, Angela Binder

Abstract: The future of mining will be characterized not only by the application of modern technology, but also by the harmonization of economic, environmental and social issues. These areas set major future challenges which are complex and demand extensive knowledge. As an example, mining of highly complex orebodies for the supply of often critical raw materials needs to consider technically demanding and cost-intensive extraction issues. The amount of tailings, which need to be stored, increases with the amount of ore mined. Therefore, the negative impact on environment and society increases. Hence mining becomes expensive with regard to all three aspects: economy, environment and society.

In view of a sustainable mining practice this challenge should be used as an opportunity. The positive impact should be maximized for present and future generations. The objective is to create and use the mining openings in an optimum way related to sustainability. The approach of Blue Mining, which focuses on energy and ergonomics in the field of sustainable development, enhances the closure planning by recommending subsequent usage of such openings for energy storage. The approach fosters among others the implementation of the 7th Goal for Sustainable Development defined by the United Nations with the assurance of access to affordable, reliable, sustainable and modern energy for all. The usage of underground storage increases the stability of solar and water power usage, which are otherwise unreliable.

Blue Mining embeds these issues in the main planning effort long before groundbreaking. This approach involves experience from past and current projects. This paper introduces the concept of Blue Mining with respect to post-mining utilization of a mine for energy storage. Methods and perspectives are presented with examples covering best-practices and lessons-learned.

Coal Mine Based Circular Economy Park: A Case Study

Zhen Wei, Dan Xu, Zhihe Wang, Gaofeng Song

Abstract: With decades of development and exploitation of coal resources, the first batch of coal-based cities in China are faced with the challenge of economic shrinkage and environment deterioration due to the rapid resource exhaustion and single industrial structure. Nowadays, as a policy instrument for sustainable development, a nationwide circular economy mode has been implemented during the design and planning of new coal mines to address the challenges arising from economic depression, energy shortage and environmental pollution. It should be mentioned that several national coal bases and most of constructing and planning coal mines are located in the underdeveloped areas in the Midwest of China which means that the distance between supply source for energy resources and the demand market is significantly increased. Moreover, the eco-environment vulnerability in these rural areas should be taken into serious consideration. Therefore, after comparison and analysis with several successful coals based and diversified circular industry chains, this paper presents a case study on the circular economy park (CEP) in the northwest

of Shanxi Province. Through discussion and evaluation of '1+3' mode in the CEP, this paper aims to enhance the understanding of coal mine sustainable development and shed light on the relationship between resources exploitation and local economic development.

Macroeconomic and Political Determinants of Resource Nationalism

Wenhua Li, Tsuyoshi Adachi

Abstract: Resource nationalism is essentially mandatory government intervention in natural resources businesses by political or economic means in order to benefit the nation and the people. It is attacking the mining industry more and more rampantly by all kinds of means since the twenty-first century. Poor countries who count on a resource-led economic growth usually find themselves trapped into "resource curse". The harmfulness of resource nationalism for investors is that one event can quickly escalate and lead to a chain of events which make projects commercially unavailable. In spite of historical and theoretical social investigations in the causes of resource nationalism, rare studies engaged in quantification of dominant parameters of it. The objective of this study is to find significant factors that dominate the occurrence of resource nationalism for important metal and energy resources producing countries and quantify their marginal effects. The study applies binary choice logit model for panel data using pooled method. One feature of the research is that binary data set of occurrence of resource nationalism is sorted out by authors referencing U.S. Geological Survey's reports. The results indicate that high-technology export (% manufactured export), ores and metals exports (% merchandise exports), rule of law (world governance indicator), trade (% GDP), and natural resource rent except forest (% GDP) dominant the occurrence of resource nationalism for high and upper middle income group countries; government effectiveness (world governance indicator), policy perception index (The Fraser Institute), high-technology export (% manufactured export), and mineral rent (% GDP) dominant the occurrence of resource nationalism for lower middle and low income countries. According to our model, probability of occurrence of resource nationalism in 90 countries is predicted. Top 10 risky countries in 2012 are estimated to be North Korea, India, Honduras, Indonesia, Kazakhstan, Burkina Faso, Mongolia, Cuba, Bolivia, and Peru. The study is a primary trial of researching on resource nationalism and provides some insights for theoretical building and simulation on the issue.

Optimization of Cut-off Grades for Molybdenum and Tungsten Open-pit Mines

Qinghua Gu, Jin Yuan, Yichuan Lv, Qiong Wu, Caiwu Lu

Abstract: The cut-off grade is one of the important parameters of mining production. Different material cut-off grade is directed to different destinations. Based on reasonable and optimal cut-off grade, long term mining plan and investment decision analysis can be made for mining managers. In view of multiple-metals open-pit, the paper has proposed that multiple-metals cut-off grade optimization model is set using the objective function to maximize net present value (NPV). The method of equivalent coefficient calculation is proposed to convert multi-metals cut-off grade optimization to a single metal cut-off grade optimization. Then the optimization model is applied in a molybdenum and tungsten large open-pit mine in china. The parameters of concentrate price are calculated by PRT in the model and the curve of grade-recovery rate is analyzed and studied according to actual production data. Based on 3D metal deposit model, the distribution of

grade-tonnage is analyzed. At final step, an optimal cut-off grade is proposed to guarantee to maximize NPV. The example shows that the model of multiple-metals cut-off grade optimization can provide reasonable analysis for optimal multi-metals cut-off grade and develop optimal production strategies.

Strategies for Highly-Efficient Recovery of Coal Resources in China

Yanghui Ren, Ruifeng Li, Hua Gao

Abstract: Since entering the new century, China's coal industry has witnessed the rapid development, and provided a reliable energy supply for the national economic and social development. But after the “golden decade” of rapid development, the coal industry now is facing overcapacity, low industrial concentration and production efficiency, high pressure of production safety and environmental protection and other prominent issues. Based on defining the connotation of highly-efficient recovery of coal resources, this paper established the relevant 8 indicators to reflect the highly-efficient recovery level of coal resources, summarized the present situation of China's coal resources recovery and the main problems, analyzed the development environment of China's coal industry under the new situation, and finally put forward the strategic measures to promote highly-efficient recovery of coal resources in China.

Analysis and Improvement of Mineral Resources Sustainability

Juntao Wang, Nozomu Mishima

Abstract: Mineral resources are in huge composition of modern society. And the continuous increasing requirements make them a risk for the whole world. Since mineral resources are non-renewable resources and the total reserves in earth are limited, even though new concept of “Urban Mine” was brought up to reduce the shortage by recovering resources from end-of-life products. However, the depletion of a certain kind of resources is still believed to happen in the near future. Except for depletion of resources, the other problem urgent to solve for human beings is environmental impacts. The most notable issues are toxic pollution and global warming due to the consumption of resources always together with the consumption of energy. So it is obviously that sustainability of mineral resources is essential. This paper begins with introduction of current system of mineral resources consumption, based on the employment of mass balance and CLD (casual loop diagrams), finally a definition of lifetime of mineral resources is put forward to perfect the current system in order to help achieve resource sustainability. It is expected that with the brought up of lifetime of mineral resources, a more sustainable society of resource consumption can be established.

Mining and the Sustainable Development Goals: A Systematic Literature Review

Rafael Fernandes de Mesquita, Andre Xavier, Bern Klein, Fatima Regina Ney Matos

Abstract: 193 United Nations members are signatories of the 17 Sustainable Development Goals (SDGs). Even though it does not make it legally binding to the country members, the SDGs establishment incites national and managerial frameworks to achieve the SDGs. The mining industry inserts itself in this context by its global presence and frequent location within ecologically sensitive and less developed areas. This paper aims to consolidate the state of academic research on mining, sustainability and sustainable development, by organizing the results of previous studies within a

systematic review on the SDGs set. To do so, the ISI Web of Science™ Core Collection database was chosen as a database of record, as it is one of the most widespread databases of academic journals. We have used all years available in the ISI database, from 1945 to 2016 (for complete years). The systematic review process comprised of five steps: (i) to search terms [(“sustainability” or “sustainable development”) and mining] on the database and to apply filters of criteria; (ii) organizing papers; (iii) metrics and relations between papers and authors; (iv) classification of the results through content analysis techniques; and (v) synthesis. The results were divided in two groups: the highly cited and the most recent papers, to include papers that have academic impact and those which show the newest contributions to the field. The results showed that, in spite of a growing amount of publications in the past years that relates to mining and sustainability, the main focus of these publications are still on the environmental dimensions of the UN goals. This suggests that more practical and academic work in the mining sector are required to fill in the blank spaces regarding the other set of goals that compose the SDGs framework.

Evaluation of Externalities Associated with Rare Earth Exploitation at Bayan Obo

Baolu Zhou, Zhongxue Li and Yiqing Zhao

Abstract: Rare earth elements (REEs) are a kind of new materials which have excellent optical, electrical and magnetic properties, and they play an important role in the development of high technology and green energy industries. With abundant reserves and a wide range of REE type, rare earth industry has a rapid development in China in recent years. However, environmental issues associated with REE exploitation have severely restricted the sustainable development of rare earth industry in China.

At present, literatures on the externalities of REE exploitation are very limited, especially in China. This paper builds an evaluation model based on life cycle evaluation to estimate the external costs of REE exploitation at Bayan Obo. The results show that the external costs for producing one metric tonne of rare earth oxides (REO) in Bayan Obo was CNY 34739 in 2013, the external costs of waste gas, waste water, radioactive substance, REE resource depletion, and land occupation are CNY 14945, 12515, 1400, 3199, and 2680, respectively. Waste gas and water constitute about 79% of the total external costs. The internalization of the external costs would reduce the financial profit of Northern Rare Earth (Group) by 18%. This study has taken into account only those externalities whose market values can be estimated, and therefore the external costs of REE exploitation in Bayan Obo is likely to be underestimated. The results fill the gap in literature and provide further understanding on the external cost of REE exploitation.

Mineral Resources for Sustainability (B)

Is it time for a Global Mining Initiative 2.0?

Michael Tost, Vighnesh Chandurkar, Michael Hitch, Peter Moser, Susanne Feiel

Abstract: From 1998-2002 the world's leading mining and metals companies developed the Global Mining Initiative (GMI) to understand their industry's role in the transition to sustainable development and to ensure its long-term contribution to sustainable development (SD). Since then, the industry has come a long way: For example, operational safety and health have improved significantly,

environmental management systems and impact assessments have become the norm, community relations have been established, many mining companies report annually on their contributions to SD and the International Council on Mining and Metals (ICMM) has taken on the recommendations of the GMI as an industry association.

However, since the GMI the concept of sustainable development has been evolving from a rather generic and loose definition (“weak sustainability”), to an absolute and strict definition of sustainability, based on the boundaries of our planet (“strong sustainability”). Similarly, other concepts such as corporate social responsibility (CSR) have evolved and even deviated from their initial intentions.

This paper presents results from a literature review looking at how far this transition has moved from a scientific debate towards becoming mainstream. Furthermore, it explores, by using qualitative comparison analysis, if the current efforts of the large mining companies are still sufficient or if the industry is again at risk of falling behind societal expectations and hence should once again come together - for a GMI 2.0 - in order to update its approach.

We conclude that the mining industry, whilst in a “weak sustainability” position and behind the peer group on climate change and natural capital considerations, is aligned with current societal expectations, expressed through the Sustainable Development Goals, and therefore there is no need for a GMI 2.0 at present.

Optimal Utilization of Low Grade Ores in Anqian Mining Company

Lihua Luan, Lianjun Guo, Chi Yang, Daning Zhang, Pengfei Pan, Houguang Sun, Donglin Xu

Abstract: Based on the introduction of production technology of Anqian mining company, the stope ore mass distribution was analyzed in detail. The processability indexes of different grade ores were obtained with magnetic tube whereas the grinding time, concentrate grade and concentrate yield were measured. On the basis of digital ore deposit model which integrates ore natural attributes and processing attributes, two stages of ore blending optimization models were established. The first stage model sought the minimum of stope ore transportation cost under the restraints of output ore grade and stope production. The second stage was a system optional model that aimed at the furthest use of resources meeting not only the production constraints of mining field and process field but also ore beneficiability and the system output requirements of the concentrate grade. Lastly, the solving method of big M simplex algorithm was discussed and used in production.

Considerations Regarding Sustainable Development in the Vietnamese Coal Mining Industry

Naoko Shimazaki, Andre Xavier

Abstract: Over 10 million tourists have visited Vietnam in 2016. Travel and tourism accounted for 9.3% of the country's Gross Domestic Product (GDP) in 2014. At the same time, as with many other resource-rich developing countries, Vietnam has been developing its extractive resources sector as a means of promoting the country's social and economic development. In 2015, mining was the third largest contributor to GDP, and accounted for 8% of Vietnam's gross domestic product. Vietnam is the third largest mineral producer in SE Asia. Although it produces zinc, nickel, bauxite, and manganese, coal mining is its most developed sector. The country has over two hundred coal mines, and total

reserves of approximately 6 billion tons. Quang Nihn Province, where the World Heritage Site Ha Long Bay is located, is a very important tourism destination. It is also a coal-rich region where mining extraction and processing have been active since the early 20th century. Vietnam is signatory of the United Nations Sustainable Development Goals (SDGs). The country is aware of the importance and the challenges involved in managing the extractive sector in a way that does not undermine its tourism industry and yet that contributes to the country's sustainable development. To this end Vietnam is taking actions towards implementing more advanced coal-mining extraction and processing techniques. The country is furthermore promoting a responsible mining sector, and is investing in programs that foster environmental protection and sustainable tourism. This paper examines the case of the Ha Long Bay region and the project involved in relocating the Hong Gai coal preparatory factory from a seafront area to a mountainside area. This paper provides a preliminary review of the initiatives adopted by the government of Vietnam to address the existing challenges that have resulted from a focus on promoting the country's socio-economic development through the exploration of its rich coal endowment. Furthermore, it also describes Vietnam's legal and policy frameworks. In conclusion this study identified that Vietnam has drafted a National Action Plan to implement the Sustainable Development Goals. The country is also taking an integrated approach to implementing the SDGs agenda and that it is assigning responsibility to a variety of ministries to achieve SDGs' specific targets. Furthermore the country is changing policies and the legal framework in order to facilitating the execution of the work of agencies that are responsible for implementation, regulation and enforcement. In this respect, the approval of the National Action Plan on Sustainable Development Goals is another important step in that direction. While the decision of supplying its internal market with high quality coal helps minimize negative environmental impacts in Vietnam, exporting low quality coal to other countries does not help resolve the problem of CO₂ emissions globally. With respect to the 2030 Agenda, this may be considered a temporary solution since to achieve the SDG goals, Vietnam will have to consider other sources of cleaner energy in order to align with the Sustainable Development Goals # 7 on affordable and clean energy.

Production Scheduling of Open Pit Metal Mine with Ecological Cost

Xiaochuan Xu, Xiaowei Gu, Qing Wang, Qingyu Zhu, Jianping Liu

Abstract: The ecological costs related to schemes were calculated based on the designed ultimate pit. Moreover, the influence of the ecological costs on the selection of production schemes was discussed. In one designed pit, a series of geologically optimum pushbacks with sufficiently small increment were produced using the floating cone method founded on the principle of the highest metal content. Then all the pushbacks were reordered by the dynamic network diagram. The production scheme with the maximum NPV route was considered as the optimum one. The ecological impacts produced by mining were quantified and the ecological cost calculation models, which contain the direct eco-value loss, indirect eco-value loss, eco-restoration cost and carbon emission cost, were proposed. In one big open pit mine case, various production schemes were optimized and the one with maximum NPV was selected without taking into account the eco-costs. The scheme with the maximum comprehensive profit was obtained by calculating the eco-cost of each scheme. The results showed that the best scheme considered with the eco-cost was not the scheme with the maximum NPV. Therefore, the eco-cost presents the effect on the selection of the best production scheme.

Zinc and Copper Recovery from Smelter Waste Stream Case Study

Frank Su, Songlin Ye

Abstract: Recycling valuable metals from waste streams has become increasingly important to the mining and smelting industry in China due to resource depletion and environmental concerns. Predicated on multiple large scale metal recovery operations designed by BQE Water at active mines in the Jiangxi Province of China, this paper presents a case study demonstrating recovery of zinc and copper from the waste stream at a major gold smelter in the Shandong Province of China. One of the issues facing the smelter is the lack of a cost-effective and robust process to recover zinc from the acidic process waste stream. As such, significant amounts of zinc-containing wastewater are neutralized with lime, resulting in not only the loss of zinc metal but also the generation of large volumes of sludge. In the case study, a sulphide precipitation process is chosen to selectively recover zinc and copper from the wastewater, in the form of commercial grade metal concentrates that can be sold as regular concentrates at the going market price. In the current project phase, over 2,500 tonnes of zinc metal and 40 tonnes of copper metal can be recovered on an annual basis. This not only generates revenue to offset waste treatment costs, but also eliminates significant amounts of sludge that would otherwise require storing and further disposal if the metals are not recovered.

The Impact of Structure Change on Copper Prices

Kegomoditswe Koitsiwe, Tsuyoshi Adachi

Abstract: This paper characterizes quarterly LME copper price fundamentals from 1995 to 2011 by analyzing the transformation of the market mechanism based on structural change perspective. Using chow test for structural change based on the least square multiple regression, we divide the price fluctuation into: Stable price period (1995Q3-1999Q2), Low stable price period (1999Q3 – 2003Q3) and Price fluctuation period (2003Q4 – 2011Q2). The results show the existence of structural breaks disproves the investigation of the full sample period as a whole. In different structural breakpoints the main drivers of copper prices changes and their impact are significantly different. Moreover, the paper examines the role of speculation in copper price fluctuations.

An Expert System for Metal Resources Exploration and Mining Feasibility Evaluation

Jianhong Chen, Qinghua Song, Shan Yang, Zhiyong Zhou

Abstract: The development process of metal resources technical and economic evaluation expert system (MRTEEES) is introduced in the aspects of requirements analysis, design of the expert system, main functions of the expert system and features of the expert system. The system is based on C/B/S mixed mode and uses ASP.NET technology with .Net Framework being chosen as the development platform and metal resources database providing data support at the bottom layer. The system is an auxiliary management system for metal resources technical and economic evaluation and has the basic functions of auxiliary decision analysis, metal resources database management, data management and comprehensive query. Technical and economic evaluation model can be set up by users independently according to at which stage a project is, mainly including exploration stage, development stage and production stage, and according to the mining methods, for example underground mining, surface mining and in-situ leaching mining. Then, the technical and economic evaluation parameters can be

generated. By inputting the value of each parameter in a simple and convenient way, the evaluation results can be directly calculated out and shown in the form of diagrams among others, and feasibility evaluation report can also be automatically generated, making the technical and economic evaluation process accurate and efficient. As the system can achieve the functions of scenario analysis, sensitivity analysis, shareholder's returns analysis, horizontal comparison of different projects, it can improve the ability of decision makers for rapid response to the rival and meet the demand of pricing negotiations.

Prediction of Ore Quantity Based on GA-BP Neural Network

Li Guo, Qiong Wu, Qinghua Gu

Abstract: BP neural network is a multilayer feed forward network trained by error back-propagation algorithm, which is one of the most widely used neural network models. However, BP neural network has exposed more and more shortcomings and deficiencies with the expansion of the application scope. In the prediction of ore quantity, BP neural network has the characteristics of slow convergence and easy to fall into local minimum point. In order to obtain the global optimal solution, and to improve the defects of BP neural network, this paper proposes combination optimization algorithm of genetic algorithm (GA) and BP neural network to improve the speed and accuracy of forecasting the main design flow chart and the analysis of the sort distinguish algorithm are offered, and then some problem in the design and debugging of the algorithm are discussed. On this basis, the GA-BP neural network model is constructed and applied to optimize the initial weights and threshold value of BP neural network. This model chooses the floating point coding method to encode the connection weights and thresholds, and divides subjects into several populations. Through the introduction of selection, mutation, crossover, initial weight and other operators, making operational synergies between the various groups. This study select 30 geological units, 8 quantitative variables (Pb, Zn, Cu, Mo, Si, Ni, Co, V) and 12 qualitative variables to carry out empirical analysis. Then the simulation of the algorithm is carried out in MATLAB and the parameters are analysed. By normalizing the input samples, 22 groups of observation data are used as the training data for prediction, and the latter 8 groups of observation data are used as the test data to be verified. The results show that when the ore quantity characteristics are not very significant, the model will produce prediction bias.

Mine Safety, Risk and Sustainability

Data Management Best Practices of Complex Socio-technical Systems: A Review of U.S. Mining Safety and Health Management

W. Pratt Rogers, Michael G. Nelson, Amy Richins, Ashley Hodgson

Abstract: Sociotechnical systems are everywhere in the modern industrial world. Sociotechnical systems describe how humans interact with technology throughout a variety of processes. These systems are prevalent in modern industrial settings, such as operating mines. Safety and health management systems (SHMSs) are complex sociotechnical structures designed with the aim of managing and reducing occupational risk. U.S. mining companies are voluntarily adopting SHMSs to supplement regulatory safety compliance efforts. Like all complex sociotechnical systems there are a wide variety of approaches and adoption philosophies around a SHMS. Many SHMSs suffer from high levels of redundancies, which manifest themselves in diverse ways: duplicate processes, forms,

permits, and tracking mechanisms. These redundancies have severe impacts on the overall system and absorb critical culture and leadership “energy”. A recent study initiated by the University of Utah and sponsored by the Alpha Foundation is investigating the effectiveness of SHMSs across 15 different U.S. mining sites. A large amount of data has been captured to help characterize elements of SHMSs and correlate their impacts on safety outcomes. Many variables were assessed in the study. Those of importance to this paper are the variables describing the robustness of the sociotechnical aspects of the SHMS. Two such variables are the overall integration of the SHMS within the whole system and how data is managed. Data management in this context deals with the approach to capturing, analyzing, and acting on data within the system. As well, systems are integrated around controlled, data-sharing mechanisms. It has been found that wide variety of approaches has been taken to integrate the SHMS within the governing management philosophy at a given site. A series of case studies is presented that develop some specific best practices for proper data management and integration of SHMSs.

Fuzzy Reliability Based Bow Tie Analysis of Coal Mine Water Inrush Risks

Cong Zhang, Huaying Wang, Yixin Wei

Abstract: Water inrush is a serious geological accident in underground coal mines. This paper focuses on the method of the bow tie analysis based on fuzzy reliability to assess the risk of water inrush in coal mines. First, post failure probability and repair probability of initiating events are divided into 5 levels. Then triangular fuzzy numbers are adopted to quantify experts' language and to acquire the reliability rate which close to the actual values by defuzzification. According to dynamic bow-tie analysis model, using the method of moments to fit the reliability time of events by Weibull distribution and offering the random sampling rule of failure and repair time for illustrating the feasibility of fuzzy reliability evaluation. To demonstrate the effectiveness of the proposed assessment approach, bow tie analysis model of water inrush in coal mines is taken as an example.

Tailings Pond Life Cycle Safety Management System

Quanming Li, Hong Zhang, Gang Li

Abstract: China, a globally recognized major mining country, holds one of the largest quantities of tailings pond country in the world. The total number of mines in China has been ranked first in the world. It is a major concern for Chinese safety management to give great importance for tailings pond safety, stability and sustainable development. For the past few years, China has increased efforts to investigate and govern discrete issues of tailings and to carry out a series of special renovation and comprehensive treatment actions to improve safety management levels and to decrease the likelihood of tailings pond accidents. In the end of 2015, China successfully eliminated hazardous tailings ponds and dangerous tailings ponds. Moreover, the total number of tailings decreased from 12,273 to 8,869. However, there are still 1,425 "head-top" tailings that threaten the lower masses' safety. This greatly signifies the Chinese tailings pond safety, stability as well as sustainable development. In turn, this may improve the Chinese tailings life cycle safety management system and help reach the goal of attaining closed-loop management in the tailings pond life cycle. Based on the summary of the tailings pond accidents in both China and other countries from 1961 to 2015, and by analyzing the types and causes of accident, this paper investigated the successful experiences and effective

measurements of British Columbia (Canada) and Australia in the tailings pond life cycle safety management. This paper summed up each country's tailings life cycle safety management requirements and analysed the characteristics and differences of tailings safety management by comparing 5 aspects: tailings life cycle safety management process, main design parameter, construction requirements, monitoring, and the tailings pond closing management. Based on these observations, this paper suggests some measurements to improve the tailings pond life cycle safety management in China, such as strengthening tailings pond safety management, improving tailings classification, increasing design parameter values, establishing mine reclamation fund, and so on.

Complex Network Model for Characterizing Hazards and Risks Associated with Mine Tailings Facility

Shuang Gao, Zhixin Zhen, Zhongxue Li, Yiqing Zhao, Xuan Qin

Abstract: If not well-managed, a mine-tailings facility may become a major source of risks, endangering the community and environment, and damaging the reputation of the minerals industry regarding sustainability. Identifying, characterizing, and mitigating the hazards and risks associated with tailings facilities have been critical to the maintenance of community-safe and environmentally sound mine-tailings facilities. Herein, a complex network model for characterizing the hazards and risks associated with the lifecycle of tailings facilities is presented. In this approach, the hazards are modeled as vertices of the complex network, and the interactions among the hazards are modeled as edges of the complex network. The complex network for modeling the hazard and risk spreading of mine-tailings impoundments is analyzed and characterized by using network metrics such as the network density, geometrical characteristics, characteristic path length, network efficiency, and clustering coefficient. The degree distribution of the network obeys a power-law distribution, indicating that the network for characterizing the risk spreading associated with a tailings facility is scale-free. According to the results of calculations and existing research results, the network is ultrasmall-world. By analyzing the change of the global network efficiency under four kinds of different methods to remove network nodes and edges, network nodes with higher between centrality (BC) are identified as critical. The removal of those critical nodes helps mitigate risks associated with a tailings facility and reveals the vulnerabilities to BC attacks.

Surfactant-Magnetized Water for Coal Dust Prevention

Botao Qin, Qun Zhou, Jun Wang

Abstract: To overcome the defects of the available dust control technologies and effectively suppress coal dust in the underground mine, the paper put forward the dust prevention technique of surfactant-magnetized water (SMW), which utilized the dual function of magnetization and surfactant to significantly improve the characteristics of solution wetting dust, achieving the efficient combination between physical and chemical dust prevention methods. To verify the synergistic effect between surfactant and magnetization, the paper carried out the experimental researches on solution characteristics under the influence of the magnetic field, such as the surface tension, contact angle and dust suppression efficiency. The results obtained from these investigations indicated that the surface tension of 0.03wt% surfactant solution magnetized by magnetic field decreased by approximately 7.2% compared to that of the original solution, while the ability of solution wetting dust was

improved, and the contact angle of magnetized solution reached 27.02° , and the dust suppression efficiency of magnetized solution increased by about 10% compared with the single surfactant solution, while enhancing about 39% compared to that of water spray. These showed clearly that the synergy between surfactant and magnetization in improving the ability of water control dust is very obvious. In addition, to effectively acquire the SMW to control coal dust, the SMW generation system, consisting of liquid adding devices, a static mixer, magnetized apparatus, was designed, realizing the aims of accurately adding the low-concentration additive and continuously producing SMW. The field application indicated that the respirable dust and total dust suppression efficiency of surfactant-magnetized water both are more than 83.5%, significantly improving the underground work environment.

Monitoring of Rock Stress Redistribution in Geological CO₂ Sequestration

Enji Sun, Erik Westman, Ben Fahrman, Xu Ma

Abstract: Shale gas has become an increasingly important clean energy, which has been explored worldwide in recent decades. Supercritical CO₂ acts as fracturing fluid for shale gas production. The safety monitoring is essential to prevent any kinds of leakage from the reservoir as the supercritical CO₂ physically stored hundred kilometres underground. Seismic tomography is an imaging technique that uses induced seismic waves to create three dimensional images of the subsurface. It is an effective monitoring method to evaluate the caprock integrity in the carbon dioxide sequestration storage (CCS). In this experimental research, a simulated uniaxial compressive load is applied on a granite sample to analyze the stress redistribution for long-term in-situ caprock integrity during CO₂ injection. The induced seismic waves are recorded and seismic events are traced based on the Geiger algorithm. The frequency of seismic events correlates with the caprock failure evolution. The acquired seismic data is divided into four regimes based on the frequency of seismic events and the failure process to examine the failure evolution. Furthermore, the travel time and distance is plotted to analyze the variation of velocity. Finally, the double difference tomography (TomoDD) algorithm using arrival time is adopted to recalculate the locations of seismic events and velocity structure in each regime. The results indicate that the passive seismic system can map the caprock stress distribution and allow for imaging of the caprock integrity. TomoDD exhibits sound improvements to relocate seismic events both in relative and absolute locations as well as to characterize the local velocity structure. The study further reveals that seismic monitoring along with TomoDD could evaluate the caprock failure accurately in the CCS.

Evidence-Based Approach to Mine Safety, Health and Environment Integrity

Zhongxue Li, Shuaiqi Wang, Yiqing Zhao

Abstract: Faced with the serious managerial situations and diverse conditions and needs for mine safety, occupational health and environmental stewardship in Chinese mining communities, an evidence-based approach is proposed for the management of mine safety, health and environment integrity. By the proposed approach, tangible and effective scientific evidence should be collected and accumulated, and the authenticity, accuracy and applicability of the evidence should be assessed to form an evidence-based approach for characterizing mine safety, health and environmental hazards and risks from multiple dimensions. The results are then used to formulate diverse safety, health and

environment functional requirements. In an evidence-based approach, the evidence is combined with the professional experiences and the actual economic and technological situations, availability and affordability of a mine. This approach is helpful to establish scientific, reasonable, acceptable and effective solutions for identifying and mitigating hazards and improving the level of mine safety, health and environment integrity of mining operations.

A Framework for Tailings Pond Drainage Failure Detection System

Cong Shi, Enji Sun, Cuiping Li

Abstract: Tailings dam is a subsidiary facility of mining production. In order to decrease tailings dam accidents caused by the failure of flood drainage system, this paper proposed a framework of potential failure detection system of tailings dam flood drainage facility based on three dimensional panorama technology. A collection device of three dimensional panorama is designed to capture the onsite images of flood drainage system of tailings dam. The spatial information of flood drainage facility of tailings dam is recovered through projecting the image information to spherical surface by using three dimensional panorama technology. Two dimensional images are transformed into three dimensional images in three stages of panorama images process, which are pretreatment, registration and splicing. Combined with the framework of HTML5, panorama images are embedded into webpage. These web pages have the functions of user interface that the images could be displayed, moved and zoomed. With the function of interaction with panoramic display, 3D panorama scenes can be changed and scaled. Browsing the webpage is helpful to find potential risks such as possible holes, fractures and leakages of flood drainage system of tailings dam. The realization of this system can detect the potential safety risks of flood drainage system of tailings dam. The application of this system would improve the safety and provide the ability of accident pre-warning. It is useful to maintain the healthy and sustainable operation of tailings dam.

Water Injection and Dust Removal in High-Pressure and Low-Porosity Coal Seam

Haiyan Wang, Haifei Yao, Yanchuan Li

Abstract: Dust pollution is very serious in coal mining process, which is a great threat to the underground staff health and equipment and facilities safety. Coal seam water injection in mining process is an effective way to reduce coal mine dust concentration at the source. However, the effectiveness of water injection is limited in high-pressure and low-porosity coal seam. To improve the moisture content of coal seam, expand the wetting range and enhance the effect of dust reduction by water injection, the injectability and influencing factors of coal water injection are analyzed by numerical simulation method, and the sealing technology under high-pressure condition is studied. Then, according to the practical conditions of Tangkou coal mine, the parameters and process system of process system are designed, the effect of high-pressure water injection in coal seam was determined by testing water injection quantity, water increment and dust concentration. It is showed that the dust-removal rate of the high dust concentration operation such as falling coal and moving frame is 63.49% and 59.72%, the maximum dust-removal rate of multi-processes is 53%, which achieve a high level of application. The research results in this paper is of important theoretical and practical value to improve the water injection effect of high-pressure and low-porosity coal seam and improve the efficiency of dust removal in coal mining process.

Mine Environment and Sustainability

Sustainable Water Management: Implications for Mining in Environmentally Sensitive Areas

Harmony K. Musiyarira, Ditend Tesh, Godfrey Dzinomwa

Abstract: Namibia is known as water stressed country with a limited amount of fresh water. Therefore, the use of water is an important topic in the country's development agenda. Water is a shared and finite resource, with high social, cultural, environmental and economic value. However, freshwater resources are under pressure from ore processing, industrialization, urbanization and the demands of a growing population. In Namibia, ore processing, coupled with the anticipated increase in water demand for human consumption and other uses, has created significant stress on the limited water resources of the country. This is critical in the mining industry as water remains typically the prime environmental medium (besides air) that is affected by mining activities. This study sought to investigate the strides made in water management in mining, especially in environmentally sensitive areas of Namibia. Most mining companies operate next or alongside farms, national parks and fishing areas. The overall objective of this research was to highlight the current practices in Namibia's mineral industry operating in environmentally sensitive areas especially in areas where uranium is being mined and processed. The methodology consisted of comprehensive literature review, field visits to the case study areas, and comparative studies with best practices. This study shows that over a ten-year period, freshwater consumption was reduced by over 55% per tonne of milled ore in uranium mines, resulting in substantive financial savings as well as the delay in water augmentation through desalination. The strategies employed by the Namibian companies involve inclusive stakeholders' engagement, recycling and reuse, and the minimization of water losses. The realization that the water challenge cannot be solved by any one party acting alone has been fundamental in ensuring environmental compliance within the mining industry in Namibia. Namibia's industrial leaders have increasingly recognized that reducing the water footprint of mining activities must be one of the key performance indicators for management. The major finding of this study was that Namibia with its unique ecosystems, mineral reserves, and emerging industries can harness a wide range of resources both to improve the welfare of its citizens and to protect the integrity of its environment.

Adsorption-Coagulation Mechanism of Composites in Treating Acid Mine Drainage

Liping Xiao, Zhe Liu, Xuefei Luan, Jichi Bai

Abstract: In order to study the removal efficiency of Cu^{2+} from acid mine drainage by prepared bentonite-steel slag composite particles, adsorption experiment was carried out. The composite particles were characterized by X-ray Diffraction analysis technique (XRD), Scanning Electron Microscopy (SEM) and Fourier Transform Infrared spectrometer (FTIR). The results show that: the composite particles can release alkali to neutralize the acid of acid mine drainage; the adsorption and chemical precipitation of Cu^{2+} occurred in the whole reaction process; the removal amount of composite particles on Cu^{2+} was 9.88 mg/g when the reaction reached equilibrium; the FTIR spectra revealed the existence of surface complexation; the SEM micrographs suggested that the composite particles would continue to adsorb and coagulate Cu^{2+} after the composite particles surface adsorbing

Cu^{2+} and forming precipitate, namely, there was synergistic reaction of adsorption and coagulation; the XRD patterns further showed the existence of cation exchange and revealed that the states of Cu^{2+} in the surface of the composite particles was Cu-Si-O mineral phase and $\text{CuO}(\text{Cu}(\text{OH})_2)$ polymerization precipitation. The bentonite-steel slag composite particles which can play a role of adsorption-coagulation synergism are excellent multifunctional green environmental mineral materials to treat acid mine drainage containing heavy metal ions.

Pathways to Shrink CO₂ Emissions in China's Coal Industry

Jinke Li, Fenghua Wang

Abstract: While coal fuelling China's economic growth it has already been causing severe pollution and amounts of CO₂ emission. How to make deep reductions in carbon emission is not only a huge challenge for the greatest consumer of coal, but also a revolution for China's coal industry. The paper explores how to shrink CO₂ emissions during the lifetime of coal. The paper points out that increase of coal mine efficiency and productivity, green mining, utilization of coal mine methane and environment-friendly disposal of coal gangue can reduce CO₂ during coal mining; coal preparation and coal by wire can decrease CO₂ during coal preparation and transportation; improving combustion efficiency, CO₂ capture and storage (CCS) and coal transformation can lessen CO₂ during coal utilization. The paper also points out that Circular Economy Park is a practical way to develop a low carbon economy for coal industry. An econometric model for total coal industry and each sector are constructed to measure carbon emissions based on CO₂ equivalent emissions, then with detailed calculations, based on potential greenhouse-gas emission's reduction, a most likely low carbon roadmap of China's coal industry is depicted with scenario analysis method.

A Review on Integrated Mineral Carbonation Process in Ultramafic Mine Deposit

Jiajie Li, Michael Hitch

Abstract: Dramatic increase in the CO₂ concentration in the atmosphere has led to the climate change, which poses a significant threat to human life on Earth. CO₂ sequestration via mineral carbonation is the one of the most effective method for mitigating global warming, and is the only way that could store CO₂ permanently. In recent years, integrating mineral carbonation via ultramafic mine deposit has received significant attention due to its high potentiality towards commercial application. This review compiles the work conducted by various researchers over the last few years on integrated mineral carbonation processes in mining industry, which use the mine waste materials as CO₂ feedstock for mineral carbonation. This paper initially introduces the basic theory of mineral carbonation, with a brief description of various techniques that enhance the rate of mineral carbonation. The enhanced mineral carbonation strategies include pre-treatment of feedstock by thermal, chemical and mechanical activation, and carbonation in a direct or indirect carbonation routes under gas/solid phase or aqueous phase. This paper then introduces the scope of application of integrated mineral carbonation. This includes the types of mine suitable for integrated mineral carbonation, the properties of mine waste materials preferable for CO₂ sequestration, and the worldwide locations potentially viable for integrated mineral carbonation. Moreover, this paper critically reviews and discusses the integrated mineral carbonation process in mining industry. The integrated mineral carbonation processes include modified passive carbonation techniques at tailing

dams, and ex-situ carbonation routes using fresh tailings. The focus of the discussions is the role of reaction condition on the carbonation efficiency of mine waste with various mineralogy, and the drawback of each integrated mineral carbonation process. All the discussions lead to the suggestions on the technology improvement in the integrated mineral carbonation process. Finally, this paper reviews the economical assessments on the existing integrated mineral carbonation process. Literature to date indicates that the value-add by-products (i.e. recovered metals, valuable carbonated products) play an important role in commercialization of an integrated mineral carbonation process.

Comprehensive Utilization of Water in Underground Metal Mine

Xianzhi Tan, Song Jiang, Minjie Lian

Abstract: The ground water heat pump system lades underground hot water which can be heated or cooled by heat exchanger in water source heat pump air conditioner. This system replaces the model of heating of air-conditioning by refrigerator and boiler. In this paper, the formation conditions of hot water energy in Shan Dong are analyzed in order to achieve the purpose of energy conservation and emissions reduction by taking full advantage of water resources such as water pouring and return water of beatification during the productive process of underground metal mine. In order to analyze the issue better, the paper points out some ways and methods for geothermal water often used in underground metal mine. This paper also presents the advantages of the technology of water source heat pump that is applied into underground metal mine. Here is a case study of comprehensive utilization of water source in a certain underground metal mine in Ji Ning. This mine, according to its own actual situation, designs heat pump heat exchange system which is used for indoor heating of buildings and bath for staff. It turns out that the system can save 23% water per year, cut down 3.303 million KW electric energy, and reduce 4160t emission of carbon dioxide. It is concluded that the technology of water source heat pump has broad application prospects in underground metal mine. Therefore, the results show that it is an ideal way to change the present structure of cooling and heating source in metal mine.

Bibliometric Overview on Energy-Water Nexus Research in the Chinese Literature

Jingli Fan, Bing Wang, Qinying Song, Fengyu Li, Xian Zhang

Abstract: With the background of water shortages and serious water pollution, issues of water involved in energy exploration and utilization have become critical problems affecting urban water usage. In order to identify the relationships of the energy-water nexus, this paper characterizes the energy-water nexus literature using a bibliometric method and based on the Chinese National Knowledge Infrastructure database platform. The results reveal that 1) Scientific outcomes in this field have increased sharply since 2003, with a slightly higher growth rate than that of general disciplines. 2) *China Water Resources*, *Yangtze River* and *Express Water Resources & Hydropower Information* are the dominant journals, and the main research fields include industrial economics, environmental science, and management, among other disciplines. 3) Hohai University, the Chinese Hydraulic Engineering Society, the Institute of Geographic Sciences and Natural Resources Research, and the Changjiang Water Resources Commission are the main research institutions in this field. However, the proportion of publications of these institutions is not high, which suggests that there is no institution dominating this field. 4) According to the keyword analysis, the hot spots in this field

include ecological environment, sustainable development, environmental protection, climate change, etc. Energy-mining related keywords have increased over time, implying that the energy-water nexus from the perspective of the energy exploitation industry can become a key issue. At the same time, the frequency of keywords related to sustainable development has been maintained at a high level, and the studies concerned with the impacts of climate change were introduced into this field relatively late. The conclusion of this study provides a foundation for a comprehensive understanding of the current situation as well as for further research in the energy-water nexus field.

Optimal Conditions for Treating Acid Mine Drainage by Bentonite-Steel Slag Composites

Liping Xiao, Wei Bin, Jichi Bai, Liu Zhe

Abstract: The Acid Mine Drainage has characteristics of low pH, high concentrations of heavy metal ions, such as Fe^{2+} , Mn^{2+} , Cu^{2+} and Zn^{2+} . In this paper, the composite particles that consisted of bentonite and steel slags were used to dispose the Acid Mine Drainage. Bentonite is the mineral materials and can adsorb heavy metal ions excellently. The steel slags are alkaline and industrial solid waste for the treatment of the Acid Mine Drainage. The main influencing factors, such as adsorbent dosages, shaking rates, concentrations of heavy metal ions, temperatures, adsorption time and pH value were studied by the static experiment. Increasing the adsorbent dosages and the concentrations of the heavy metal ions, speeding up the shaking rates, raising the temperatures, extending the adsorption time and improving pH would improve the removal efficiencies of heavy metal ions. Through considering the removal efficiencies and the treatment costs, the optimum reaction conditions for the four kinds of heavy metal ions were obtained. The adsorbent dosage 21 mg/L, the rotational speed 120 r / min, the temperature 25 °C, adsorption time 100 min and the initial wastewater pH 7. The four kinds of heavy metal ions existed independently in the simulated mine wastewater. The highest initial concentrations of Fe^{2+} , Mn^{2+} , Cu^{2+} and Zn^{2+} were 150 mg/L, 100 mg/L, 170 mg/L and 140 mg/L respectively. The removal rates were 93.42%, 92.64%, 93.86% and 95.17% respectively. The determination of the particles' SEM-EDS Microscopic characterization showed the composite particles could play a part in neutralizing, absorbing and the chemical precipitation. The acidity decreased notably and the heavy metal ions of Fe^{2+} , Mn^{2+} , Cu^{2+} and Zn^{2+} were adsorbed and precipitated effectively. The research results can extend the practical engineering application of the composite particles.

Waste Water Treatment Plant for Sewage Water in the Sharrcem Plant

Halil Berisha, Shkurta Gashi, Kostas Kouklidis, John Mastoris, Kostis Dragasakis

Abstract: Water is increasingly recognized as a critical issue for sustainable development, becoming as important as carbon to corporate responsibility and reputation. Although the cement industry's overall 'water footprint' is relatively small compared to other sectors, the Cement Sustainability Initiative of the World Business Council for Sustainable Development (WBCSD/CSI) has recognized the importance of water and the need to take actions towards efficient water management, with developing standardizing practices and employing a risk-based assessment approach, mostly at local level where individual facilities and activities can have implications for other water users in the area. Sharrcem, a member of the Titan Cement Group, has made significant investments to upgrade its

production facilities, the technological process and apply environmentally friendly technologies. Under this frame, Sharrcem implemented a project for the construction of a Waste Water Treatment Plant (WWTP) in the Cement Plant facilities, which has been successfully operating since early 2016. This paper discusses the technology applied at the new WWTP and the results achieved already, with significant improvement in the quality of the treated water, as compared to the previous situation where untreated wastewater was directly discharged to the nearby Dimce Stream. The WWTP project is a major investment of Sharrcem that aims to improve the quality of the discharged water effluents and thus prevent potential river pollution and overall protect the environment and the health of Sharrcem employees and local community. The WWTP operates with the Sequencing Batch Reactors technology, is fully automated and has been also connected with few households of the neighboring community to treat their sewage water. The plant can be expanded in the future - to connect with additional households - without increasing the size of the treatment tanks. One of the benefits of this project is that by removing a variety of contaminants from water it becomes usable again, depending on the nature of the contaminants and the end use of the water treated. According to the monitoring results the treated water that comes out of the WWTP fully meets quality requirements according to the EU and local limit values standards.

Mining Development and Communities

The Role of Participatory Environmental Monitoring Committees in Mining Regions in Peru

Andre Xavier, Aldo Leon, Alexandra Carlier, Manuel Bernales, Bern Klein

Abstract: Mining companies and governments at both the local and national levels recognize that Participatory Environmental Monitoring and Surveillance Committees (PEMSC) are necessary mechanisms for meaningful engagement at the community level. In many cases, PEMSCs are established as volunteer initiatives by mining companies or by the mining communities themselves. In Peru however, they can also be recommended by the government as way to address social conflict. Most PEMSCs are launched while a mine is in operation and have the objective of monitoring both water quality and quantity. Many established committees are currently evolving and adopting a more comprehensive approach, as well as expanding their initial scope from a river or micro-basin focus and watchdog agenda, to a broader regional integrated resources management view. This paper examines the origins of Participatory Environmental Monitoring and Surveillance Committees in Peru. It also discusses the typology of these committees, and the scope of their work. Furthermore, it looks at the challenges faced by these committees, as well as existing opportunities for mining companies, governments, and civil society. Finally, this study presents a governance model that could contribute to the long-term existence of these committees. This discussion is further informed by the results of a national workshop that took place in October 2016 in Peru, in which over 200 representatives from 22 monitoring committees, government and mining companies participated.

Wetbud - A Free Water Budget Modeling Tool for Created Wetland Design

Stephen Stone, Zach Agioutantis, G. Richard Whittecar, W. Lee Daniels, Tess Thompson, Kerby Dobbs

Abstract: A common result of Environmental Impact Assessments associated with mining projects is the construction of new wetlands in areas disturbed by mining operations. Where appropriate, this mitigation may be considered an integral part of the mine reclamation process under the principles of sustainable development in the minerals industry. Wetbud is a new tool for estimating wetland water budgets using available weather data and site-specific topographic, soil and geohydrologic data, coupled with mass balance mathematics. Wetbud is primarily intended as a planning tool for use in the design of created wetlands, but it can also be applied to native wetlands or wetland restoration sites where the required input parameters can be specified. Wetbud can be run in its basic form where wetland topography, soil parameters and groundwater flux are simplified, or in the advanced form, where these parameters are included in a more complex approach via integration of the MODFLOW package, a free 3D program that was developed by the United States Geological Survey. Both versions can also include overbank flow hydrology sources and the advanced form can also model sloping and irregular topography. The program downloads weather data from the nearest applicable station and selects appropriate wet-normal-dry (W-N-D) years following a modest user data clean-up step. Wetbud also has the ability to utilize existing short-term (e.g. 6 to 9 months) groundwater data from an up-gradient well to simulate longer-term groundwater level inputs for the selected W-N-D years. In addition, Wetbud features a “Wizard” version that comes pre-loaded with 14 pre-selected weather data sets for all areas of Virginia that can develop a simple monthly water budget in less than 15 minutes - a feature that could be expanded anywhere geographically with historic weather data.

Public Engagement and Sustainable Energy Development

Ellen S. Gilliland, Emily A. Sarver, Leigh-Anne H. Krometis, Michael Karmis

Abstract: Public engagement is increasingly important in ensuring the success of projects related to energy development, particularly with regard to issues of environmental protection, public health, and socio-economic impacts. This is due to concurrent trends in public behavior, including a rise in public interest in these projects that is not matched by a rise in science literacy, and increasing organization and participation of the public through social media, citizen science, and grassroots initiatives. In recent years, several high-profile incidents have demonstrated that when public concern is ignored or met with a passive response from industry, it can rapidly grow into organized opposition that negatively impacts or wholly derails a project. Engaging, listening to, and educating stakeholders during early planning and development phases are therefore essential to earning credibility and trust. Moreover, maintaining two-way lines of communication throughout the lifespan of a project demonstrates social responsibility and facilitates cooperation, acceptance, and even support from communities and others. Positive experiences with specific projects at a local, community level can influence the larger public opinion of an entire industry sector. This paper presents case studies of public engagement related to shale gas development (including hydraulic fracturing and pipeline construction), mountaintop removal mining, and management of mixed-use watersheds near surface mining operations. The experiences highlighted in these case studies are

used to draw best practices of public engagement for sustainable energy development.

Interventions for Ensuring the Sustainability of the Small Scale Mining Sector in Namibia

Harmony. K. Musiyarira, Ditend Tesh, Mallikarjun Pillalamarry, Nikowa Namate

Abstract: Many reports have been written about the issues surrounding small scale miners' challenges in Namibia; yet little has been done to address these challenges. There has been a fragmented approach to address these challenges. Various government arms and donor organizations have utilized piece meal methods in the past in trying to make improvements on the productivities across the sector, but with no meaningful success. This has led to the design and implementation of inappropriate technologies and support services for the sector. The structures of many of the semi-precious stones mining businesses are informal, with very little royalties received by the government. Miners often work informally or illegally and they fear government interference and they distrust outsiders, resulting in them withholding production information. The presence of small scale miners is quite often associated with major challenges, including poor safety and environmental management standards, the spread of communicable diseases and poor working conditions. The majority of the miners employ uncontrolled extraction techniques which damage the crystals and mineral specimens, resulting in intermediate and final products of low quality along with high wastage at the extraction stage. The vision of the Namibian government is to expand the range and value of semi-precious stones and jewelry products processed within Namibia, while curbing illicit flows of raw stones. This will simultaneously secure maximum benefit for the country. This study investigated the interventions aimed at making the small scale mining sector in Namibia sustainable. A baseline study was conducted to analyze the current situation and characterize the industry, including a SWOT analysis. Information was collected through questionnaires, interviews, consultative meetings, field visits and workshops in order to profile the sector. The baseline study results were used in developing interventions for improving artisanal and small scale mining operations. The main challenges for the Namibian semi-precious sector were identified as: factual information about raw material resources and its beneficiation are insufficient or not available, lack of skills, lack of education and access to finances, rudimentary exploration and mining practices, trading and logistics that are not functioning effectively and inadequate sector governance. One key finding of this study was that Namibia is not benefiting through value addition due partly to illicit flows of the uncut stones and to the fact that lapidary is not much pronounced to a greater extent. The following strategic interventions were identified as key in ensuring the sustainability of the small mining sector in Namibia: conducting geological assessment to identify new deposits and quantify the existing ones, improving exploration and mining practices, investing in education and training, creating an enabling environment and improving the sector governance and strengthening the sector organization and supporting the infrastructure.

Contribution of Artisanal and Small-Scale Mining to Sustainable Territorial Development through Strengthening Capabilities of Mining Communities

G.A. Aristizábal-H, O.J. Restrepo-B, J.A. Delgado-J

Abstract: In Antioquia region of Colombia – South America most of extractive activity is developed

as artisanal and small-scale level, exploiting different types of minerals resources but predominantly gold. This is not only an ancestral livelihood of hundreds of families in this region, but also their unique way of subsistence. However, that situation has not had a positive effect in the sustainable development of this territory because of several unsustainability factors mainly related to mercury use for gold extraction, the incorrect management of tailings and the informal way in which miners perform their activity. In 2010 Antioquia was the place with the highest contamination by mercury in the world with serious effects in ecosystems and health of habitants of this region (Veiga 2010)

This paper presents a Socio-Technical Model focused on strengthening capabilities and social capital of artisanal and small-scale miners and its surrounding communities in Antioquia region. This is based on processes of evaluation, design and implementation of appropriate technologies to obtain “clean minerals” without using mercury and with a right management of tailings. In gold extraction it is about gravitational methods of concentration, which take advantage of high density of this element. These methods not only are cleaner but more profitable for miners.

Notwithstanding its technical origins, the current model proposes a holistic framework that manages the elimination of mercury in mining not only as a technology transfer matter. Thus, more than formalization the strengthening process seeks to promote a business vision in miners and to develop productive chains in surrounding communities, this means to improve the skills of artisanal and small-scale miners to organize in a corporative way and to help surrounding communities to provide support and supply services to mining and even to other companies. Besides, the articulation with local institutions drives to reinforce their functions of control and accompaniment. In shorthand, this effort aims to empower local institutions, miners and surrounding communities in such a way they are able to face together their own development challenges in a sustainable way.

[Technology and Capacity Building for Sustainability](#)

Investigation of the Effect of Drill Bit Rotation Speed on Sustainable Drilling

Niyazi Bilim, Sertaç DüNDAR, Bilgehan Kekeç, Arif Emre Dursun

Abstract: Estimation of rock drillability is vital for mining and boring operations. For this purpose, many researchers have developed various models and equations to estimate rock drillability. Most of these models aim to determine the drillability of rock and the penetration rate by using the physical and mechanical properties of rocks. Although drillability primarily depends on rock properties, other parameters have an impact on drillability as well. One of these parameters is the rotation speed of the bit. This study investigates the effect of rotation speed of the bit on drilling performance. Drilling tests were performed in the laboratory using rotary core drilling and a diamond drilling machine. The relationships between the physical rock properties and the penetration rate were investigated on 15 different rock types and four different rotation speeds were applied to determine the effect of rotation speed of bit on drilling. The uniaxial compressive strength, density, and P wave velocity show strong correlations with the penetration rate. In addition, if the values of the physical and mechanical properties of the rock increase, the effect of the rotation speed on the penetration rate decreases, i.e., increasing the rotation speed of the bit slightly affects drillability on hard and solid formations.

Control Mechanism and Support Technology of Soft Coal Roadway in the Fully Mechanized Mining Work Face

Genshui Wu, Weijian Yu, Jian Zhang, Yong Ning

Abstract: Aiming at characteristics of the soft coal roadway engineering geology and deformation, the exposure research of the soft coal seam, theoretical analysis, numerical calculation and program design were carried out. First of all, according to the disclosure, soft coal seam engineering characteristics and geological conditions in Xinxing coal mine were expounded. Meanwhile, the soft coal roadway bolt supporting axial effect, the bolt supporting transverse effect, the anchorage body mechanics strengthening mechanism and problems such as supporting strength have been analyzed. The paper pointed out that the soft coal with very small cohesive force can form a composite anchorage body under the combined action of the anchor cable group, the W-type steel band and the metal net. The soft coal body in the plastic damage area formed anchorage balance arch with a certain bearing capacity and adapted to the rock deformation, and which played an effective support role in the roof outside the balance arch of the roadway. Therefore, the full-cable support technology was proposed. And then, numerical calculation and comparative analysis were conducted on three schemes of the roadway with non-support, with combined support of “anchor bolt and cable” and the full-cable support. The results show that when the roof is supported by anchor cable, it not only controls the continued increase of the subsidence value of the roof, but also effectively suppresses the convergence amount of the floor heave value and the amount on the sidewalls of the roadway. Whether it is from the stress distribution situation, or the viewpoint of plastic zone scope, the combined support of full-cable is more reasonable than that with non-support and that with the combined support of “anchor bolt and cable”. Finally, based on the features of soft coal seam in No.2265 work face of Xinxing coal mine, the relevant support schemes were put forward, and its specific support parameters and cross-section designs were drawn as well.

Abrasion Properties of Some Building Stone Wastes and Usability for Sustainability

Bilgehan Kekec, Niyazi Bilim, Sertac Dundar

Abstract: Knowledge of the abrasion resistance of aggregates is important when using them for asphalt and concrete mixes and highway construction materials. In this study, the usability of natural building stone waste as aggregates for different engineering applications was investigated. To this end, test samples were obtained from a number of natural stone quarries and stone cutting factories. The abrasion tests were carried out on the test samples and results were compared between samples. The abrasion strength values were determined with both the Micro-Deval (MDe) and the Los Angeles (LA) abrasion test methods. A correlation coefficient was also determined between the LA and MDe tests results using an appropriate statistical model.

Application of Three-Dimensional Geological Modelling in Coal Mining

Liyan Ren, Huayang Dai, Yingcheng Li, Enquan Wang

Abstract: Three-dimensional geological modelling of coal mines is critical to the sustainable development of the mining industry. On the basis of comprehensively analyzing 3D geological modelling methods, according to the available data of mine such as geological terrain maps,

cross-sections and boreholes, we present a 3D modelling method by integrating ArcGIS and 3D GeoModeller. Our motivation is to integrate the advantages of both software modules in processing, converting, integrating and transferring geological information. Special attention has been given to the data structure and processing flow. We build a 3D geological model of the Xieqiao coal mine and successfully extract the geological framework of the strata in the 11118 workface, consistent with that of the actual explored geology.

Design and Analysis of a Kind of Centralized Forced Flip-Flow Screen

Chusheng Liu, Zhenqian Wang, Jida Wu, Mengqi Zou, Wei Zhao, Wenqiang Qiu

Abstract: During the dry screening, the hole plugging is a serious problem for most traditional screening equipment sieving the moist fine coal. It would lead to the low preparation efficiency and the low screening efficiency. The flip-flow screen is a new kind of screening equipment by using flip-flow motion of elastic screen surfaces to implement the separation of material. With the remarkable advantages of the extraordinary vibration intensity of screen surface, the hole is difficult to be plugged, and the screening efficiency is improved. In this paper, a kind of centralized forced flip-flow screen (CFFS) was proposed based on the crank rocker mechanism. The flip-flow motion of elastic screen surfaces is achieved by the periodical reversed motion of inner and outer screen boxes driven by crank. The advantages of the CFFS include considerable deformation of the screen surface, stable flip-flow quantity, low working noise, low vibration influence on environment, etc. The principle and construction of the CFFS were introduced, and the modal analysis and harmonic response analysis of key components (the crank and the linkage) were implemented based on finite element method (FEM), respectively. The first six orders of natural frequency and vibration modes were obtained. The maximum equivalent stress and strain under working and resonance frequency were achieved. The results illustrate that the resonance frequency is much higher than the working frequency, and the stress and strain are all within the safe limit of the material. The prototype was manufactured, and the sieving experiment demonstrates that the CFFS perform steadily, and screening efficiency is over 80%. The new feasible method of the dry screening was proposed by the CFFS. The corresponding numerical simulation and the experiment provided a reliable basis for the future promotion of similar product design and research.

Preparation of High Purity Manganese Sulphate from Low-Grade Rhodochrosite

Zefang ChenLi, Laijun Ma, Lei Mao, Fang Lian

Abstract: In our work, the preparation technique of high pure manganese sulfate directly from low-grade rhodochrosite ore (MnCO_3) was studied and improved intensively, including the effective leaching process and the short purifying process. Based on the same ion effect, the repeated leaching of rhodochrosite with sulfuric acid is proposed to improve the solubility of Mn^{2+} and inhibit the dissolution of the impurities Ca^{2+} and Mg^{2+} . Moreover, the repeated leaching process could make full use of rhodochrosite and lower the dosage of sulfuric acid as raw material. With the aid of theoretical calculation, $\text{Ba}(\text{OH})_2$ was chosen to adjust the pH value of manganese sulfate solution, and BaF_2 to remove Ca^{2+} and Mg^{2+} completely in the process of purifying. The results demonstrate that the extraction ratio and the recovery ratio of manganese reached 94.3% and 92.7%, respectively, which shows the prospect of industrial application. In manganese sulfate production, the heavy metal

impurities have been decreased to less than 1ppm. Moreover, the content of calcium, magnesium and sodium has been decreased to less than 20ppm, which meets the standards of high pure reagent for energy and electronic materials. Our study enlightens an approach to the sustainable application of low-grade rhodochrosite.

Flow Behaviors in a Cyclonic-Static Micro-Bubble Flotation Column

Xiaokang Yan, Lijun Wang, Rui Shi, Yu Liu

Abstract: Cyclonic-static micro bubble flotation column is a novel floatation equipment for refractory minerals separation. It has been successfully used in metallic minerals and coal floatation for its high selectivity and small separation-size. It can get better separation efficiency with a shorter separation process compared with flotation cell. To understand its working principle and superiority, in terms of fluid dynamics, an unsteady-state, three-dimensional, gas-fluid two- phase flow numerical simulation using CFD commercial software FLUENT is performed. This column has three parts, which are column unit, cyclone unit and pipe unit. The streamline, velocity, gas holdup and turbulent parameters of both phases in these three parts were obtained. The streamlines inside illustrated the flow patterns in these three parts behave as counter-current flow, rotational flow and jet flow, respectively. The turbulent kinetic energy and dissipation rate is gradually increasing to compensate for the decreasing of floatability of mineral particles. This column floatation innovatively integrates several flow patterns into one column and the turbulent energy is intensified step-by-step, is the key reason to get a higher separation efficiency for fine particles.

Stress-Zone Based Support Technology of Large Section Coal Roadway

Feng Cai

Abstract: As a new method to support gate roadways, rock bolting has been widely used in the big coal enterprises for its superiority. The disturbed stress field of surrounding rock and anchor pre-stress field were divided into 3 areas in consideration of σ_1 , σ_3 . The surrounding rock failure form and characteristic were analyzed in combination with parameter f , the failure mechanism was explained using the slip line theory, furthermore, the rock bolting mechanism and its arrangement were studied. After roadway excavation, the tensile stress area appeared at the surface of the surrounding rock. The failure type changes from shallow tension-shear form into deep compression-shear form and the failure shape is an “incense burner”, surrounding by high risk failure area in butterfly shape. The maximum principle stress in roof appears discontinuous distribution because of layers separation. The failure type of surrounding rock is intensity-stress environment-weak plane control model. The internal reason of roadway macroscopic failure is the displacement between the surface plastic area and the deep elastic region along the tangential direction of slip line. In condition of rock bolt support, there is one-way tensile stress area in small range at the surface of surrounding rock, inside is the bidirectional compressive zone in uniform distribution form, stress environment is improved by the superposition of anchor pre-stress and disturbed stress field, anchor rock bolt arrangement and pre-tightening force distribution is decided according to the distribution of f parameter. Finally, supporting method and parameter reasonability was proved by the roadway deformation monitoring, damage depth drilling peep test in the 8101 transportation roadway in a mine.

Social Responsibility and Sustainability

Emergence of Differential Social License: A Case of Impact and Benefit Agreements in Nunavut, Canada

Michael Hitch, Michael Tost, Susanne Feiel, Peter Moser

Abstract: Impact and Benefit Agreements (IBAs) are intended to be a negotiated agreement between an industrial proponent and a community, local or regional citizens' organization. Although the elements have grown over the past two decades from a simple agreement to exceedingly complex legal frameworks, the intention remains the same: to outline the roles and responsibilities of the two stakeholders and the natural resource development on their lands beyond environmental assessment. These agreements were born out of comprehensive indigenous land claims and have become the cornerstone of community engagement today in most indigenous nations. In the case of mixed communities, those that have beneficiaries of land claims and those who are not, social acceptance remains uneven and reflective of an unequal distribution of decision-making power (political ecology). This Differential Social License can cause conflict and a breakdown of the societal fabric that binds communities of diverse populations, resulting in inequality, fictitious wealth generation and failure of infrastructure.

This paper presents a case study of how the development of Differential Social License developed in the Hamlet of Cambridge Bay, Nunavut as a result of an IBA negotiated between Tahera Diamond Corp. and the Kitikmeot Inuit Organisation in 2004 for the Jericho Diamond Mine.

Sustainable Mining - a Case Study in Canadian Practice

D.H. Steve Zou and Cui Lin

Abstract: This paper first discusses the basic attributes of sustainable mining and the responsibilities of various stakeholders including mining companies, governments, and engineers. It is followed by a brief overview of the current practice on regulations, inspections, waste management and mine closure planning in Canadian mining industry. A case study is then presented as an example of sustainable mining where mine planning, mineral recovery, environment protection, reclamation and community development were integral parts of the overall strategy. A comparison of the mine site before and after mining is made to demonstrate the "best practice" in modern mining.

Children's Experiences of the Coal Mine Disaster: Analysis of Junior High School Students' Essays in Yubari City

R. Kasahara

Abstract: In 1981, a gas outburst accident occurred in the Yubari Shintanko coal mine, the only expectant mine in Japan, it caused 93 deaths. As a result, Yubari Shintanko closed in 1982. This major disaster was a turning point for sustainability of Yubari City, the largest coalfield in Japan. Finally, Yubari City was bankrupted in 2007. This paper aims to explore how miner's children experienced this disaster and felt about region, family, and themselves, and to explain the relation between region declining and children's lives. The data of this paper are the archived 600 essays, written by the junior high school students at the time of the disaster. There are three findings. First, the children who lost their father were the most shocked. They faced profound sadness. But they

expressed that they had decided to overcome their sadness with surviving family. Second, the children who didn't lose their father were also influenced. They were anxious about the future of Yubari, their family, and themselves. Furthermore, they decided to strive for their future. Third, they understood the disaster as a turning point of Yubari declining and looked ahead their future outside of Yubari. In conclusion, this disaster created their hopelessness to Yubari region and, as a result, promoted the decline of the city through their migration to other city. Furthermore, it is important to clarify that Yubari City has to continue the struggle to the regeneration.

Evaluation of the Senior Coal Mine Managers' Working Stress

Qi He, Rong Guo, Jinsuo Zhang

Abstract: Coal mine ranks No.1 among the 6 major high-risk industries, so it is no doubt that the senior managers in the coal mine bear more stress than other industry executives. The massive working stress results in serious influences on the physical and mental health of the senior managers of coal mine, which might also induce the safety risk in the coal mine. Therefore, to evaluate the senior managers' working stress and put forward strategies of mitigating the stress is of great theoretical and practical significance in improving the physical and mental health of the senior managers and reducing the safety risk in the coal mine.

The research on the working stress has been made in the western countries for almost 50 years, China began the research in the mid and late 1990s, the research is spread across multiple industries including education, medical treatment, computer and aviation. However, there is little research on the senior managers' working stress of the coal mine, so the available literatures are few. In the paper, we, based on the working stress model of Robbins and through questionnaire survey, analyze the element composition of the senior managers' working stress of the coal mine; then, we construct the evaluation indicator system of the senior managers' working stress of the coal mine based on the individual factor, organization factor and environment factor; after that, we determine weights of each evaluation indicators by using the improved triangular fuzzy number weight method, and set up the evaluation model of the senior managers' working stress of the coal mine on the basis of the fuzzy comprehensive assessment method. At last, in accordance with the model, we evaluate and analyze the working stress for the senior managers of some typical coal mines, and diagnoses the major sources and intensities of the senior managers' working stress, and then propose corresponding strategies of mitigating the stress.

Exploring the Significance of Earning a Social License to Operate in an Urban Setting

Lysa Morishita, Dirk van Zyl

Abstract: Mining companies are increasingly approaching the social aspect of sustainable development within the rural communities that neighbour their projects and operations. Rural community engagement requires significant effort and resources, and it can be extremely challenging for mining companies to earn and sustain social capital. The focus on rural, proximal community engagement is not to be understated and has led to significant benefits in many communities. However, opposition to mining projects is often exhibited in urban environments, where there may be potential for mining companies to gain social capital with relative ease. Cities tend to have existing frameworks for community engagement and public activation, such as annual parades and festivals,

that make it easy for a mining company to provide financial support or value-in-kind. Local organizations and community groups can achieve the same amount of engagement in an urban environment with significantly less effort required from the mining company. By applying simple marketing principles to community engagement strategies, corporations can increase awareness for their business and encourage city residents to think critically about the origin of resources. Unlike many corporations, mining companies are not marketing or selling products to individual consumers. From this arises the opportunity for a company to use marketing to promote other positive initiatives and, as such, connect their brand with positive messaging thus earning social capital. This may lead to a wide variety of secondary impacts including benefits to recruitment efforts, increased political support, and positive media coverage. This paper explores these matters with special reference to Vancouver, BC, Canada and the mining companies Teck and Goldcorp.

Case Study on Quarry Rehabilitation and Land Resettlement in Dimce Quarry

Halil Berisha, Jenuz Bulica, Shkurtë Gashi, Kostas Kouklidis, John Mastoris, Kostis Dragasakis

Abstract: Titan Group's environmental policy and Sharrcem's corporate social responsibility (CSR) are the driving forces behind the development and implementation of a comprehensive Rehabilitation Plan at Dimce Quarry, which is the main raw material source for Sharrcem Cement Plant since the 1970's, located in the municipality of Hani i Elezit in Kosovo. Based on an Environmental Impact Assessment Study and the approved Mining Plan and also on the principles prescribed in the Guidelines on Quarry Rehabilitation, released by the Cement Sustainability Initiative of the World Business Council for Sustainable Development (WBCSD-CSI), Sharrcem has adopted a quarry operation and rehabilitation process in line with the best practices in the mining and cement sector. This paper discusses the background for the development of the rehabilitation plan and the results of rehabilitation activities, as have been implemented over the last few years. The main objective of the progressive rehabilitation plan at Dimce Quarry is to restore the depleted pit and return it back to the original land owners for resettlement. To date approx. 3,4Ha of former mining area has been restored by backfilling and leveling of the depleted closed pit and returned back to owners, who have built their houses and turned it into a living area again. This Quarry has turned out to be a real composition and practical example of preserving and returning back the natural resources in a state compatible with the surrounding environment and with respect to the needs of the local stakeholders. The motivation for business to engage in rehabilitation activities in the first place lies in the belief that the development and implementation of a progressive and practical Quarry rehabilitation plan and restitution of the land will deliver significant environmental and social benefits that outweigh the long-term rehabilitation costs, while maintaining the company's reputation.

About SDIMI 2017 Proceedings / 关于论文集

A total of 92 abstracts and 70 full papers were collected. They were double reviewed online by 51 international peers and as a result 49 of the those papers were finally selected and published in the Open Assess ebook (ISBN 978-0-9948791-3-4) titled Mineral Exploitation and Sustainability - Proceedings of the 8th International Conference on Sustainable Development in the Minerals Industry (SDIMI 2017). The ebook and proceedings are now available on USB flash drive and soon after the conference will be made available online in an Open Journal System for open assess.

About SDIMIs / 关于 “矿业可持续发展国际会议”

The main objective of this series of International Conference on Sustainable Development in the Minerals Industry is to assist the global minerals industries in their transition to sustainable development.

The first conference, SDIMI 2003, was very successfully held in the island of Milos, Greece and attracted 200 international attendees. On that occasion, the "Milos Declaration" was adopted, a statement of contribution to a sustainable future through the use of scientific, technical, educational, and research skills and knowledge in minerals extraction and utilization that was endorsed by the leading global professional and scientific organizations and institutes representing the minerals professional.

The second conference in this series, SDIMI 2005, was held in Aachen, Germany, and was again a successful forum in convening the minerals community engaged in sustainable development, with particular emphasis on sustainability indicators, data evaluation and reporting and life-cycle assessment and product stewardship.

SDIMI 2007 returned to Milos, Greece. The focus of the meeting was on issues of benchmarking, SD value creation, operationalization of SD, creation of knowledge hubs, modeling and fiscal issues and best practices and tools. The meeting provided opportunities for presentations and panel discussions. The conference was organized in three tracks representing a variety of stakeholders, which can provide guidance and direction to the minerals community on the path to sustainable development.

SDIMI 2009 was held in Brisbane, Australia, July 6 - 8. Themes included: Frameworks and tools for integrating sustainable development considerations into mine and plant design, Innovative methodologies for measuring sustainable development performance at the operational, corporate and industry level, Mining and minerals processing in a carbon-constrained world: reducing the GHG footprint, Sustainable development challenges in emerging mining countries, Community impacts and benefits of mineral resource developments, Stewardship and the management of products and wastes, Cumulative impacts of intensive resource development, Advances in life cycle and sustainability assessment, Industrial and regional synergies, Overcoming the barriers to the uptake of sustainability innovations, Integration of sustainability thinking into professional education.

SDIMI 2011 was held again in Aachen, Germany in the framework of the AIMS conference. Organization was very successful and delegates from many countries attended the event. A young professional event attracted a lot of attention.

SDIMI 2013 returned to Milos once more. The main theme of the meeting was the development, monitoring and assessment of sustainable development criteria for mineral operations. The Conference also aimed to conclude with a consensus plan and a process, representing a variety of stakeholders, which can provide guidance and direction to the minerals community on the path to sustainable development.

SDIMI 2015 was held at the University of British Columbia in Vancouver Canada. The theme of the conference was Integrating Economics, Community, Environment and Governance.

SDIMI 2017 is being held in Beijing, China, June 26 - 28. The theme of the conference is Adapting Mineral Exploitation to Sustainability for Safety, Health, Environment and Community with merging economies and global economic transformations.

SDIMI 2019 will be hosted by UNSW in Sydney, Australia, June 24 - 26, 2019.