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Produced by
Ye Jiaolong, Ma Chanhua
Sichuan Institute of Nuclear Geology

For
Asia-Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org

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Part One: Seminar Report

5-7 September 2018

Chengdu, China

A three-day seminar, focusing on the innovative and sustainable development of traditional mining industry, was held in Chengdu, Sichuan Province, China, from 5-7 September 2018, by Sichuan Institute of Nuclear Geology, under the support of the Department of International Cooperation of the Ministry of Science and Technology of China and the APEC Secretariat, Various economies, government entities (ministries, councils and other institutions), research institutions, public or private universities, and the private sector participated in the workshop. With the dialogue involving different aspects, the three-day event attracted about 50 participants (70% men and 30% women). It was conducted in three special topics, with the theme of policy innovation, technological innovation and development in the transformation and upgrading of traditional mining development and industry.

"Mining industry is at the front-line of transformation by science technology and innovation. This conference is supposed to strengthen the technological cooperation and communication in the field of sustainable mining development, deepen the cooperative sense between APEC economies, promote the common prosperity and development of APEC economies," said Ms Liu Zhongzhen, Project Director of the APEC Secretariat.

MTF's Chair Mr Rodrigo Urquiza Caroca delivered a greeting video to seminar opening ceremony, he said "Mining is at the vary stage of most of the evaluating process, sustainable mining is a must as it sees, prosperous are demanded by all stakeholders, Both the MTF and PPSTI are in harmony of interest, and I welcome to say each other the inter-fora collaboration cross-fora as requested by the leaders, and take advantages of the synergies are key factor for the APEC future."

The overall feedback from the participants indicated that the seminar provided a platform for important innovative technology information, tools and policy dialogues to assist APEC members in promoting traditional mining transformation and upgrading. One of the results noted in the feedback evaluation form collected is that the them can be more refined, with more thematic directions added, indicating the need and interest to continue to focus on the sustainable mining and innovation transformation of APEC. The main aspects of each topic are as follows:

Session One - Technology Dimension of innovative and sustainable mining

It was shared by experts from Chile, China, Mexico, and Thailand, their technological innovations and application developments in mining exploration, mining, production and other aspects. These developments emphasized the important needs of accuracy, safety, integrity and timeliness of the use of technology, with corresponding measures proposed. The delegates participated, through case sharing, exchanges and discussions on this topic, reached a consensus and agreed that it is more feasible to improve technologies that are practical for developing economies than the invention of cutting-edge technologies. With the development of science and technology, technology continues to innovate, more and more advanced cutting-edge technology or cutting-edge instruments, therefore, are used in the mining industry. It is not necessarily the best choice for APEC economies, especially developing economies. It will be more suitable for the development status and mode of developing economies through learning from the successful experience and technology of other economies and combining with local actual conditions to improve and upgrade the technology.

Session Two - Policy Dimension of innovative and sustainable mining

This topic focuses on what kind of policy support is needed for traditional mining transformation and upgrading and sustainable development Representatives from different economies learn from other economies by sharing their classic cases and successful experiences. Dr Penda Diallo, a Lecturer in Sustainable Mining Camborne School of Mines, University of Exeter, presented the case of sustainable Mining and the Need for Multi-Stakeholder Engagement-Observations from West Africa, introduced their local experience and noted the recent improvement. The general recommendation is that sustainable mining is not impossible; it requires strong commitment and cooperation from stakeholders and the need to improve mining education and related resources.

Chile shared its production development and innovation strategy in the mining sector. Currently, the objective of the production strategy is to enhance the competitiveness and production diversification of Chile by encouraging investment, innovation and entrepreneurship. In addition, it’s necessary to strengthen human capital and technological capabilities to achieve sustainable development of geographical balance.

Mining is not just a mine, an engineering, but an economic combination, with the needs of government's support and guidance. From the perspective of enterprise, the most important benefit is the maximum predictability, which is also a huge value to governments in this aspect.

Session Three - Development Dimension of innovative and sustainable mining

With the increasing exploitation of mineral resources, we will strengthen the comprehensive evaluation of resources for mines with depleted resource exploitation, develop and utilize various companion resources, fully explore the potential of local resources, foster the development of the continuous replacement industry with good development and competitiveness, and guide the industrial transformation and form a new leading industry as soon as possible.

The case of the Golden Melon Stone Museum shared by Chinese Taipei is a successful experience in the reuse of resource-exhausted mines, which is worthy of learning. On the basis of protecting local resources, it has gained new development, providing a new direction for the future development of the local area. It is not only a strategic choice for the transformation and development of traditional mining innovation, but also an innovative practice to promote scientific popularization and implement the quality education for all.

Conclusion:

It is concluded that the mining industry is at the forefront of technological innovation transformation. The mining innovation and sustainable development are key issues that many APEC members have long focused on and actively explored. The seminar not only strengthens the connectivity of the mining industry, but also provides the mining industry with a platform for innovative technology and policy dialogue. It's not just a corporate social responsibility activity, nor a social license to acquire and maintain activities operated by developers and governments to promote the overall and sustainable growth of mining. Instead, it should be a common goal based on the shared value of all stakeholders and be targeted at inclusive growth. The exchange of best practices and policy recommendations among participants, private sector representatives and APEC member economies is a mechanism for moving closer to APEC's full implementation of mining transformation for APEC economies. It is recommended that it is necessary to continue this discussion and focus on the specific needs of mining innovation and sustainable development.

Part Two: Project Previous Research

Preface

With the integration of the global economy, the geological prospecting industry should be actively integrated into the domestic “13th Five-Year Plan”, fully expand exchanges and cooperation with economies and regions along “The Road and Belt”, actively participate in the cooperative development projects of international energy and mineral resources, and establish a service concept of “going out ” and “great geology". The development concept of “going out” is an urgent requirement for China’s huge demand for resources. Domestic resources only cannot meet the needs of China’s economic development so international market should be made full use. The service concept of "great geology" is in line with the requirements of the times.

“There are some new changes, new trends, and even historical changes in geological undertakings or geological work.” At present, industry regulations and policies relating to geological exploration are being or will be adjusted or revised; profound changes are taking place in the geological work structure, especially industrial structure. The basic and important status of green exploration, digitalization and intelligent exploration will be further highlighted; strategic minerals and deep earth will be a new field of China's energy resources development.

Under the new normal, new situations and new problems objectively exist in China's mining and geological prospecting industry, and the strategic structural adjustment of mining is imperative. At present, it should be clear to face six major challenges for China's geo-exploration industry: first, the overcapacity; second, mineral geological work shrinks significantly; third, the mixed system of enterprises and enterprises comes to an end; fourth, there is crisis in market integrity; fifth, the construction of risk exploration capital market lags behind; Sixth, geological exploration has not yet entered the rule of law.

Geological work must actively adapt to the new tasks and new requirements put forward by the new normal of economic development and serve the economy's major strategies more actively. We should take initiative to change the mode, adjust the structure, and pave a new way with geological characteristic actively, rely on deepening reform and innovation drive

Under the new situation, there is much pressure on the adjustment of the mining structure and the transformation and upgrading. Affected by factors such as the world economic downturn, slowing demand, energy structure adjustment, and concentrated release of production capacity due to high-intensity investment in the previous period, the global supply of mineral products is over-represented, prices fall sharply, and the growth rate of mining fixed-asset investment slows down. The price competitiveness of domestic mineral products is not strong, mining enterprises are generally difficult to operate, and coal, steel, cement and other industries have excess capacity. At the same time, the world's new energy, new materials and other strategic emerging industries are developing rapidly. The demand for minerals has gradually become prominent in strategic emerging industries such as unconventional energy, rare earth, antimony, antimony, lithium and crystalline graphite. Although China's related mineral resources have comparative advantages, the level of industrial development is low and the protection of resources needs to be improved. Mining development must adapt to market changes so we must adhere to innovation and development, accelerate the adjustment and transformation of mining structure, and develop five types of mining industries: “innovation-driven, reform-oriented, green-safe, inclusive and shared, open and mutually beneficial” to enhance sustainable development.

1. The Status of China's Mining Industry

Mineral resources are the material basis for human development. In the past few decades, in order to obtain rapid economic development and get rid of the predicament of passive beatings, China has had to adopt an extensive and compressed development path for a period of time, and it quickly completed the development task that other economies took hundreds of years to complete, which makes China be the second largest economy in the world. It has created amazing miracles and laid a material foundation for the dream of a powerful economy.

At the same time, however, it has also caused a severe situation of “tightening of resource constraint, serious environmental pollution, and degradation of ecosystems”. Under such a circumstance, China's traditional mining development model is not sustainable. The situation is undoubtedly a huge challenge for China's geological exploration, especially mineral exploration, but it also brings opportunities for the single geological work structure, especially geological exploration industrial structure adjustment and transformation and upgrading.

1.1 Situation of geological prospecting industry in China

With the global mining industry recession, geological prospecting units that have been mainly engaged in geological exploration have changed their concepts and expanded their markets under multiple pressures of domestic economic growth slowdown, mining investment tightening and overcapacity. Faced with the new normal and new situation, the geological exploration units will mainly transform their business areas from mineral exploration to the geology of the people's livelihood, and through actively moving out of their homes, active services and other measures, build a large geological work pattern and actively expand environmental geology, agricultural geology, urban geology, tourism geology, shallow geothermal energy, groundwater pollution control, urban underground pipe network detection and other fields.

① **New pattern in the depth adjustment of geological exploration**

（1） Geological exploration investment continues to decline, and the role of fiscal fund is highlighted

Under the impetus of market pressure of oversupply and the domestic structural reform of the supply side, the adjustment of the supply of geological exploration market has been further increased, and part of the geological exploration work with excess supply has further shrunk.

（2） Investment in resources has fallen while in environment has increased, and the green transformation of geological exploration has taken effect.

With the change of domestic resource and environment demand, the investment in resource-based geological exploration continues to decline while the environmental geological exploration continues to rise. However, the overall structure of geological exploration focusing on mineral resources has not changed fundamentally, and the protection of domestic resource security remains the main work of geological exploration.

（3）The differentiation of mineral exploration investment

Although the growth rate of demand for mineral resources in China's economic development has slowed down obviously, the total demand is still a high. The main body of geological exploration is still mineral exploration, and the rigidity in demand for mineral resources has not changed fundamentally. However, with the continuous deepening of China's economic restructuring, the demand for different mineral resources continues to differentiate. According to the changes in exploration inputs of different minerals, there are three kinds of trends in the following 2012: rapid decline, slow downward and stable fluctuations.

（4）The intensity of geological exploration in the deep part has increased and the difficulty and cost of exploration have increased significantly.

With the improvement of the geological work in the shallow part of the earth and the increase in the demand for deep resources and environment, the depth of geological exploration work is constantly deepening. The construction and development of land surface in urban agglomerations centered on large and extra-large cities has reached a high level. The development and utilization of underground space has become an important way to alleviate urban traffic congestion and environmental pollution so it is urgent to find out the deep geological conditions of the city.

With the increase of exploration depth, the difficulty and cost of geological prospecting are obviously increasing. The same new and identified resource reserves as before require more capital.

② The new equilibrium of supply and demand driving geological exploration continues to optimize

（1） The driving force of mining development has slowed down, and the proportion of mining industry has shown a downward trend.

The driving forces of mining development include the development and expansion of industries such as manufacturing, infrastructure construction, and urbanization. At present, the growth rate of these downstream industries has slowed down significantly, and the mining development momentum in the upstream has weakened. As the economic structure continues to optimize, the proportion of mining in the domestic economy is slowly declining.

（2） The geological environment bearing capacity is close to or reaches the upper limit, and the ecological protection pressure is increasing sharply.

In recent years, the pressure on regional geological environment in China, driven by rapid industrialization and urbanization, has been increasing. When more and more regions approach or reach the upper limit of geological environment bearing capacity, the geological environmental pollution and geological disasters have become China's current and major environmental issues that need to be taken seriously in our economy at present and in the long run. Geological environmental pollution continues to spread, seriously threatening the health of the people.

1.2 Economic Analysis of Geological Prospecting Industry in China

(1) The situation of geological prospecting economy in China is not optimistic

According to the questionnaire survey of the “Geological Prospecting Industry Development Situation” conducted by the China Land and Resources Economic Research Institute in December 2016, under the current economic situation, for the economic situation of China's geological prospecting around 2020, only 15% of the respondents were more optimistic, 15% expressed optimism, 26% could not make judgments; As for about before and after 2030, only about 17% respondents were more optimistic, 17% expressed optimism, and up to 48% said it was difficult to say.

(2) The outstanding achievements in marine geological work

In the context of the continuous downturn of mining economy, the focus of geological exploration work is also quietly shifting. According to the latest survey, environmental geology, urban geology and agricultural geology have become the three most potential areas in the field of future development of geological exploration.

(3) It is expected that the investment in non-oil and gas geological exploration in China will be further reduced in 2017.

According to the prediction of the Chinese Academy of Social Sciences, the world GDP growth rate in 2017 is about 3.0%. It is believed that the world economy faces more fragile financial markets, weak growth in trade and investment, more and more unequal distribution of income and wealth, an increasingly anti-globalization trend and many major challenges. The global mining recovery process will also depend on the overall trend of the world economy and the development of major economies. Coupled with the reform of the mineral resources and equity system, the financial funds used for geological exploration will be further reduced. On the whole, the domestic non-oil and gas geological exploration investment will be further declined in 2017, and it is expected to decrease by about 10%.

(4) Transformation and development is imminent

Under the situation of economic downturn in the geological survey, how the domestic geological exploration units survive and develop has attracted the attention and exploration of the people in the industry. First, “big geology” broadens the business scope of geological exploration units. Second, scientific and technological innovation promotes the transformation and upgrading of the geological exploration industry. Third, “the Belt and Road Initiative” strategy creates more opportunities for the development of the geological exploration industry. “The Belt and Road Initiative” strategy involves rich mineral resources in the economies or regions. The “going out” of domestic geological exploration units has geographical advantages, work foundations and cooperation space. In the face of new changes in the international environment and new requirements for domestic development, geological exploration units should fully grasp the opportunities of "the Belt and Road Initiative" development strategy, actively carrying out overseas geological exploration, and promoting deeper and higher levels of foreign exchanges and cooperation.

2. Mining transformation and upgrading demands

At present, geological exploration work is in the context of a major transformation and great change. First, the construction of ecological civilization has been integrated into the overall layout of the “five in one”; second, the strategic layout of “four comprehensive”, especially the comprehensive deepening of reforms, is being coordinated and promoted; third, economic development has entered a new normal, and supply-side structural reform has become the primary task; the five development concepts of innovation, coordination, green, openness and sharing are being thoroughly implemented; fifth, the world science and technology revolution is having a profound impact on various industries including mining; sixth, the global mining industry, after expiring a decade of prosperity, has gone through a trough period and is still in a period of deep adjustment from the second half of 2012 to the first half of 2016.

On the whole, the basic and advanced status of geological exploration remains the same as before. The long-term fundamentals of geological exploration have not changed, and the demand for geological exploration in economic and social development has not diminished, but the structure, content and requirements undergoing profound changes. There are five main changes: first, the transition from resource-based to multiple resources such as resources, environment, and space; second, the resource-based geology transformation to clean energy minerals and strategic emerging minerals from traditional solid minerals; third, the changes from shallow to deep, from land to ocean, from the domestic to both the domestic and foreign; fourth, the transformation from providing a geological report by collecting data to finding mining solutions through big data; fifth, the shift of focus from quantity to quality and efficiency.

2.1 Domestic policy demand

Under the new normal of economic development, the contradictions and problems of China's mining system and mechanism are rigid; resource constraints are tightening; ecological problems are prominent; and people's livelihood demands are increasing. Therefore, China's mining industry must go out of the dilemma, achieve medium and high-speed growth, move to the middle and high-end level, form a new competitive advantage, and achieve comprehensive, coordinated and sustainable development. It must be guided by the development concept of innovation, coordination, green, openness and sharing and understand and grasp the newly issued policies and regulations on promoting the development of mining science. Efforts will be made to build a “five-type mining industry”, namely reform-led mining, green and safe mining, inclusive and shared mining, technologically innovative mining, and open and mutually beneficial mining.

2.2 Economic development demand

High-quality development of the economy requires higher quality energy and other important mineral resources. The geological survey of the new era, whether to ensure the safety of energy resources or to serve the work of the Land and Resources Center, should take the initiative to play the role of the foundation. Geological work serves all aspects of economic and social development and plays an important basic and pre-emptive role in economic and social development.

At present and for a long period of time in the future, there are five major needs of economic and social development for geological exploration. The first is the demand for geological prospecting work in domestic energy and resource security; the second is the demand for geological prospecting work for disaster prevention and mitigation, and the third is the demand for geological prospecting work in new urbanization, industrialization, agricultural modernization and major engineering construction; the fourth is the demand for geological exploration work in the construction of a marine powerhouse; the fifth is the demand of the domestic defense and army construction to geological prospecting geological exploration work. At the same time, with the implementation of a series of major domestic strategies, many new demands will continue to emerge.

2.3 Ecological civilization construction demand

The geological survey of the new era should be taken around the initiative of ecological civilization construction. The geological survey is not the destroyer but the creator of the ecological environment. Through the exploration of clean energy such as coalbed methane, geothermal heat and shallow low temperature, the quantity, quality and distribution of the shallow geothermal energy resources in the region are ascertained. Scientific and rational development of clean energy provides an important basis for the promotion of ecological civilization; through the monitoring of geological environment of groundwater resources, a scientific basis is provided for the rational development and utilization of groundwater resources, prevention and control of water pollution in key river basins, and the construction of a water-saving society; through the classification of geological achievements, a reasonable spatial pattern is formed, which provides an important guarantee for human life. Therefore, strengthening the construction of ecological civilization not only plays an important role in economic development, but also plays an important role in the harmonious development of man and nature.

2.4 Demand of servicing and protecting of people's livelihood

Geological survey work should be based on serving the people's livelihood and ensuring the people's good life. First, we must increase targeted support services to help the poor in poverty-stricken areas, and provide support services for local development of green mining and characteristic industries and improvement of people's livelihood conditions. Second, it is necessary to strengthen the prevention and control of geological disasters, comprehensively strengthen the investigation, monitoring and prevention of geological disasters such as collapse, landslides, mudslides, and ground subsidence to improve the ability of disaster prevention and mitigation. The third is to support the service for rural revitalization strategy, major project construction, etc. These all illustrate the important role of geological work in the protection of people's livelihood, and also reflect the geological survey work with the fundamental purpose of people's livelihood.

2.5 International cooperation demand

Actively respond to the “Belt and Road Initiative” to promote bilateral and multilateral cooperation in the field of geology and mineral resources. Adhering to the spirit of the Silk Road, we will establish a community of interests, a community with a shared future, and a community of responsibility to solve the universal problems that we human being faced with. The economies along the “Belt and Road Initiative” are rich in resources and complementary with China. More importantly, economies along the route have strong complementarities with China's mineral products supply and demand and related industrial structures. At the same time, Central Asia is rich in oil and gas resources, but its exploration and mining capacity is weak, infrastructure construction is insufficient, and the industrial system is imperfect. In these respects, China has rich experience and high-quality and abundant production capacity. Therefore, there is huge space for cooperation.

3. Mining transformation and upgrading direction

At present, the global economy is gradually recovering, and the international mining market is gradually out of the downturn. The situation of exploration investment and exploration financing has obviously improved so mining activities have become increasingly dynamic. In this context, China is implementing a more comprehensive, deeper and more diversified opening-up strategy to the outside world, deepening the transformation and upgrading of the mining industry, and creating a shared, mutually beneficial and open mining industry. Focusing on the global economic and mining situation, new concepts, new patterns and technologies in the fields of new economic normality and mining opportunities, "Internet + mining", mining and financial innovation, geo-cooperation among economies (regions) along “the Belt and Road Initiative", green mine construction, geological data service, etc., will be the direction of the development of traditional mining industry.

"Green development, deep mining, intelligent mining" will be the three major development themes in the metal mining field under the new normal. We will vigorously promote the construction of digital mines, develop mine information technology; develop intelligent mining equipment, promote intensive mining of deep wells; upgrade the level of mining equipment to promote the transformation of mining methods; and drive green development and promote the transformation and upgrading of mining.

3.1 Green exploration

The old road of the extensive mining economy at the expense of the environment has been unable to adapt to the new requirements. The construction of green mines aims to achieve rational development and utilization of resources, resource conservation and environmental protection. It is an inevitable choice for mining development, and green exploration is a direction of mine transformation.

Green exploration is guided by the concept of green development, with scientific management and advanced technology as the means, with the goal of generating both environmental and economic benefits, and minimizing the environmental impact of geological exploration. Green development is the real solution to mining development and ecological environment and the only way to highlight contradictions. The green development of mining industry is an important part of green development. It is necessary to solve the mining environment problems caused by mining engineering activities with the concept of green development; not only must we pay attention to some negative environmental effects of mines, but also fully exploit the positive effects; considering the restoration and management of mine environmental management, it is necessary to have a systematic rectification idea, system planning, and integration with local industries and regional economic development to contribute to local social and economic development; technological innovation is the fundamental and core of green mine construction to enhance the competitiveness of green mines with technological innovation.

① **How to do a good job in green mine construction?**

Practice has proved that the construction of green mines is an important direction for mineral resources management and mining development under the new situation. However, how to ensure that the expected goals are achieved in view of the current mining situation and the difficulties and challenges in the construction of green mines?

First, the summary of green mine construction should be done well. It is necessary to further summarize the practice of pilot green mines in various places, especially the fresh experience and effective measures, to see what can be used as demonstration and replication promotion experience.

Second, further strengthen the promotion of green mine construction. All localities have accumulated good experience in the construction of green mines, and explored many effective models to enhance the awareness of the whole society to save intensive use of mineral resources and protect the ecological environment, so that the construction of green mines becomes a social consensus and the conscious action of the whole society and the whole industry.

Third, further establish and improve the green mine standard system. It is necessary to conscientiously summarize, study and absorb the standards set by relevant industries, clarify the policy boundaries, and gradually improve the standards for green mine construction by region and industry.

Fourth, promote the establishment of a long-term mechanism for green mine construction. The construction of green mines is not only a matter for the land and resources department, but also involves many other departments such as finance, taxation, science and technology, and industrial credit. Establish a policy combination of incentives and constraints for green mine construction, and develop targeted, systematic, and operational policies and measures to make mining development healthier and more sustainable, and form a long-term mechanism for green mine construction.

Fifth, actively promote the construction of a green mining development demonstration zone. The main body of the enterprise, policy guidance, and government support should be combined to promote the construction of green mines from point to entire area.

3.2 Deep mining

Along with the increase in the exploitation of shallow mineral resources, metal mines especially, are gradually moving towards deep mining. However, deep mining faces many environmental and technical challenges. For mines that are in the transition from automation to intelligence, green mining and deep mining are the topics that must be considered in their future development. New ideas, new models and new technological innovations, including green development and intelligent mining, have become the key to deep, safe, efficient and environmentally friendly mining.

① **The main problems of deep mining**

First, the problems of deep high stress that may lead to destructive ground pressure activities, including rock burst, landslide, puking, water gushing-out and other dynamic disasters caused by mining excavation; second, the problems of lithological deterioration, the transformation of shallow hard rock to deep soft rock, and the elastomer becoming a latent plastic body, imposes a great burden on support and mining safety, seriously affecting mining efficiency and benefit. Third, the high temperature environment of deep wells, the temperature of the rock layer increases with the gradient of 1.7 ℃/100 m ~3.0℃/100 meters. The high temperature environmental conditions of deep wells seriously affect the labor productivity of workers, and in order to effectively cool down, the mining costs will be greatly increased. With the increase of mining depth, the lifting height of ore and various materials is significantly increased, the difficulty of upgrading and the cost raising are greatly increased, and the production safety is a threat.

At the same time, the major problems of well construction, mining technology, lifting transportation, ventilation cooling, filling, rock movement prediction, etc. involving in safety production in ultra-large-scale and ultra-deep well mining are inseparable from the deep well lifting wire rope testing device and the tail of large processing capacity. Research and application of key equipment such as mine concentrated storage devices and ultra-large-scale metal mine transportation intelligent control systems; relevant technical standards for deep metal mining are also to be established and improved.

These key problems in deep mining are also the core issues that need to be faced and addressed in intelligent mining in the future.

3.3 Intelligent mining

With the increase of global demand for mineral resources, the entry of high-yield, high-efficiency, high-quality, low-cost mineral products from the international market, as well as the exploitation of some unconventional predatory mining products in China, the competition among the resources, management and market of mining enterprises is increasingly fierce, forced mining companies to make changes in resource utilization, environmental protection, mining processes, technical equipment, and safety management to meet the current severe challenges.

Intelligent mining refers to intelligent and automated mining equipment as the core, high-speed, large-capacity, two-way integrated digital communication network as the carrier, intelligent design and production management software system as a platform, through real-time, dynamic, intelligent monitoring and control for mine production objects and processes, to maximize the safety, efficiency and economic benefits of mining.

Mine Intelligent Mining Technology is a series of interdependent, interconnected functional modules that are integrated through real-time data streams to form an organic whole. Its core functions include mine production planning, mine production system operation, mine operation status monitoring and intelligent mining equipment.

① **The significance of intelligent mining**

The significance of intelligent mining mainly lies in the use of modern high-tech to upgrade traditional industries, promote the development of mineral resources to efficient, safe, green and sustainable development, and enhance the core competitiveness of the mining industry.

② **The main problems of intelligent mining**

At present, the main problems of China's intelligent development are: the technical level of mining equipment is relatively backward, especially its automatization and informatization level can not meet the requirements of intelligent mining; lack of underground integrated communication, positioning and navigation with independent intellectual property rights to achieve intelligent mining support technology and software platform; related technology research power is scattered, failing to form a strong R & D team.

③ **The development trend of intelligent mining technology**

The overall development trend of intelligent mining technology is mainly reflected in the following 10 aspects: first, the three-dimensional visualization system of mine surface, deposit and engineering environment model; second, the effective production management information system, including mine planning, mining plan, production plan, statistical scheduling, production monitoring, geodetic management, operation management, etc., forming an enterprise local area network; third, the network system for video and data transmission on the same network, and multimedia communication network with fiber or radio communication as the main body to realize distributed sharing of mine data; fourth, to achieve automatic collection and processing of mine production process data, through sensor network technology, in order to achieve production process, mine safety, equipment operation monitoring and data automatic acquisition and visualization; fifth, to achieve centralized control of mine production system, through intelligent control system, and the centralized control of lifting, transportation, ventilation, drainage, etc.;

Sixth, to realize the digitization, modeling and visualization of mine resources, design optimization, production planning and mining environment through computer software system ; seventh, the mining blasting integrated design system and process monitoring system, based on digital mine platform; eighth, through multimedia, imitation, simulation, virtual technology to reproduce the whole process of mining and production process, including scheduling, process monitoring, disaster warning, etc.; ninth, the real-time dynamic response of information integration through the entire production process, to achieve centralized control of the main mining equipment or unmanned programming control; tenth, the use of automatic positioning and navigation system of intelligent mining equipment, so that the mine achieving remote operation of the production process from a single process to the entire system.

In short, the application of the new model of mine intelligent mining can greatly improve the intelligent manufacturing level of the industry, promote the transformation and upgrading of traditional industries, improve the core competitiveness of enterprises, and also achieve the reduction of staff and efficiency, improve the working environment of personnel, reduce the labor intensity, improve mine safety and promote social harmony.

3.4 Great geology

Geological prospecting is the main business of geological exploration units. No matter how it is transformed, the status of mineral geology or energy mineral geology cannot be shaken. The main business is still the same, and it cannot be paralleled with environmental geology and people's livelihood geology.

① **How should new geology work?**

The first is basic geological work, namely regional geological surveys and scientific surveys. The basic geological work degree is high, but it is done by various means in different periods in history, rather than a full coverage, so the basic geological work cannot be shaken and must be further strengthened.

The second is hydrogeology. Water is the responsibility of other departments, but hydrogeology is the responsibility of the geological survey department. In these years, geological exploration units have carried out geological water exploration in water-deficient areas, making great contributions to drought emergency response. Therefore, geological exploration units have a lot to do in clean water exploration, emergency water source exploration, and population gathering areas and water source exploration around the city.

The third is environmental geology. To a certain extent, the restoration of the geological environment of the mine is still a low-level environmental treatment for filling the trees and planting trees, and there is no scientific and technological content. The scientific and technological content of comprehensive geological environment management is relatively high and from the original highway along the visible range of the focus of the treatment, and extend to the comprehensive management of the geological environment of resource-exhausted cities.

The fourth is ecological geology, including two aspects. One refers to the ecological geochemical survey, which is the agricultural geology that many people say. It is different from geological survey and sampling survey. Now we should focus on strengthening the ecological geochemical survey and increase the investigation and development of beneficial elements. The other is ecological restoration. As far as the treatment of heavy metal pollution is concerned, the technology is still not up to grade. Geological exploration units must take the path of ecological restoration combined with physics, chemistry and biology to make a difference.

The fifth is engineering geology. Engineering Geology is a discipline which uses the principle of geology to serve engineering application, which is widely used in engineering planning, surveying, design, construction and maintenance. However, in the specific practice, engineering survey and construction, which belongs to the exploration department or the construction department, is not clear. There is also a comprehensive evaluation of the underground available space. Any team engaged in engineering geology will do it, and the space of the geological survey unit will be compressed.

Sixth is geological tourism. Geological tourism is very hot nowadays. However, the development of geological tourism resources must be of high quality, high grade, and taste. It is impossible to exploit and occupy the market with low quality. At the same time, we must highlight two main lines: one is to revolve around the main line of resources and environment to strengthen the exploration of minerals; another is to focus on the main line of services and do a good job in six aspects to better serve the construction of ecological civilization and serve economic and social development.

3.5 New energy exploration

In response to global climate change, the world's energy transformation characterized by the replacement of fossil fuels and nuclear fuels with new energy is rapidly advancing. Green, low-carbon and environmental protection have become synonymous with the development of the times. In this energy transformation, economies around the world have different ways and practices to deal with energy transformation due to differences in resource endowments, energy consumption structures, and policies and laws. Domestic geodetic institutions, as a technical support force, focus on the potential evaluation of unconventional energy resources, research on development technologies, research and development of key technical equipment, and environmental impacts on hydraulic fracturing, etc., supporting the energy transformation of economies.

Based on the considerations of energy security, environmental pollution, climate change and other challenges in the sustainable development of human society, the wave of the world energy revolution, in recent years, has come one after another. The US shale gas revolution and oil production technology have made a breakthrough and the global energy grid is interconnected, effectively promoting clean and electric energy replacement. In this competition of energy transformation, the western developed regions responded quickly and positively. Different regions have different ways and methods to deal with energy transformation due to the resource endowments of economies/regions, the structure of energy consumption, the status of import and export trade, and the different policies and laws.

In general, the global macroeconomic uncertainty and structural changes will affect the energy demand pattern. The low energy prices and increasingly fierce competition will reshape the energy exploration and development pattern. The rapid changes in the energy technology field will greatly promote the world energy. In this transformation, low carbon, green, and environmental protection will dominate the trend of the times. Underground energy resources, especially natural gas, will become a “transitional gas” for human civilization to enter the era of green economy due to its clean and low-carbon characteristics, and its importance will be significantly improved. At the same time, the development and utilization of geothermal resources will also be another energy source to accelerate energy transformation.

3.6 Tailings utilization

In all kinds of minerals, the useful components of many ores do not reach the industrial indicators developed and utilized under the technical and economic conditions of a certain historical period, and must be subjected to beneficiation to enrich the useful components into available standards, and from the selected ore is extracted and the remainder of the ore is the tailings.

A genetic type of exogenous deposits is the tailings. It is a mine accumulation deposit that re-migrates and accumulates of minerals or elements on the surface of the earth during the mining process. The important feature is that the ore structure is loose and contains a variety of components. It is a comprehensive deposit of mineral source materials (including artificially added).

The depth of human exploitation of mineral resources is an important indicator of the stage of economic and social development. The minerals used for development and the depth of each of the utilized minerals are expanding with the innovation of science and technology. In the accumulated tailings in the past, there are many useful components that can now be extracted, and the remainder of the extraction can still be found for their availability. Some tailings do not rule out the possibility of tailings in a tailings pond or tailings in a certain area being almost completely reused in the case of strong technical, economic and market demand.

Mineral resources are the material basis for human economic and social development. Therefore, the development of mineral resources is synchronized with the economic and social development process, in line with the scientific development concept, realizing resource conservation and protecting the requirements of human living environment. Therefore, it is necessary to strengthen the scientific and research work of comprehensive utilization of tailings to provide technical support, talent, funding and working conditions, as well as corresponding economic policy support.

3.7 Back-end reuse of mine mining

Combining the two themes of resource and environment, while deepening excavation of resources, expand the content of environmental ecology, such as mine parks, mine museums, mine tourism, and even mine science experience, turning waste into treasure. According to the development direction, it is divided into commercial commerce, leisure vacation, urban tourism, theme park or landscape park and adventure sightseeing based on museums and festival activities.

（1）Museum mode

The museum is a cultural and educational institution that collects, preserves, researches and displays cultural relics and serves the society. It is an important part of tourism resources and is a must for many tourists, especially those with certain cultural level. The adoption of the museum model is both an important means of mining heritage tourism and a protection of mining heritage resources.

The use of tourism resources development of museum-mode mining heritage, one is that in the area of mining relics concentrated, it can establish a live museum, according to the principles of heritage protection integrity and authenticity. The original form of mining heritage left over from the mining process can be preserved and appropriately transformed. Some production processes and processes can be reconstructed and restored, which is a development project that visitors can more intuitively and truly perceive the mineral resources. The second is to re-select the address, establish a comprehensive mining museum, and display the mining relics, the natural geography where the mining area is located, the historical folk culture and other related cultural relics, comprehensively reflecting the development level and historical development process of human social productivity.

（2）Landscape park mode

Under the premise of maintaining the authenticity and integrity of the ruins, the landscape park mode makes full use of the existing architectural relics, space facilities and environment, carries out landscape renewal, mining relic restoration and reconstruction of the mining area, and appropriately adds modern cultural elements. It demonstrates the value of mining heritage to visitors while providing them with a place to visit. It can culturally continue the glory of the mining area, on the other hand, it can harmoniously integrate mining heritage resources with modern life to meet the needs of people at all levels. It is an extension and expansion of the rational use of heritage resources on the basis of sufficient grounds for heritage.

（3）Comprehensive development model

In order to give full play to the attraction of the heritage resources, a comprehensive development model can be adopted in the development of mining resources. It is a comprehensive development that integrates visits, excursions, shopping, leisure, scientific research, education, etc. in specific mining heritage sites. This comprehensive development is both a comprehensive use of resources and a comprehensive function. It not only respects the value attributes of heritage resources, comprehensively utilizing mining heritage resources, but comprehensively develops the mining heritage sites to give new functions to tourism management. The comprehensive development model is more suitable for heritage sites with obvious location advantages and good traffic conditions.

Part Three: Best Practices Report

Session 1: Technology Dimension of innovative and sustainable mining

Case 1-1: Deep exploration technology of gold mine in Jiaodong area, Shandong Province

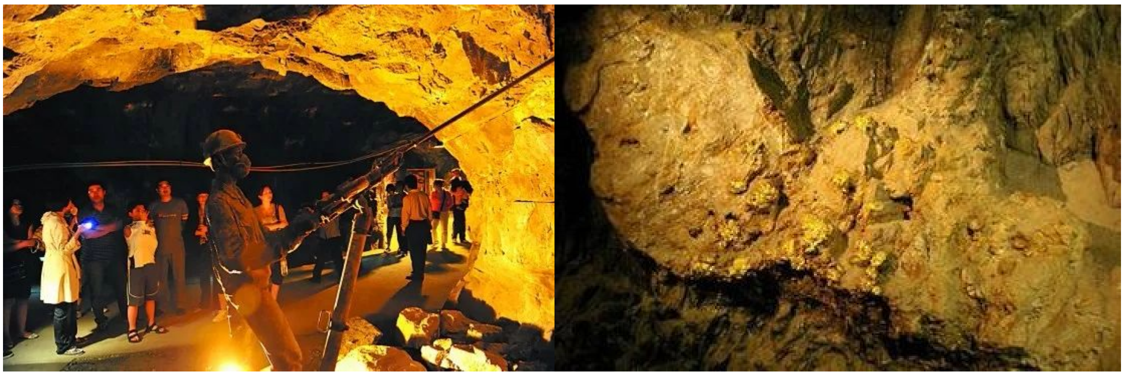
Practice Name: Deep exploration technology of gold mine in Jiaodong area, Shandong Province

Implementing unit：China.

Practice Summary:
Since the implementation of the prospecting breakthrough strategic action in 2011, the deep exploration of the gold mine in the Jiaodong area of Shandong Province has achieved significant results, and a number of large and extra large gold mines have been identified.
While the Jiaodong area has made major breakthroughs in prospecting, the technological innovation capability of geological prospecting has also been significantly improved. The understanding of metallogenic theory has been deepened, the study of metallogenic model of deep large-super large gold deposits in the gold deposit area of northwest Jiaodong, Shandong Province has been carried out, and the “hot-stretching” metallogenic theory and stepped metallogenic model of the Jiaodong-type gold deposit have been established; the prospecting theory of gold prospecting has been enriched and for the first time the “Trinity” prospecting prediction geological model of prospecting prediction geological model of Jiaodong Gold Mine based on “metallogenic geological body, metallogenic structure, metallogenic structural surface and mineralization characteristics”, which has greatly enriched and developed the theoretical system of gold prospecting and exploration in China; the gold ore prospecting method is innovated, which systematically summarizes the lateral law of veined ore bodies, and significantly improves the effect of deep prospecting exploration; gold exploration technology has achieved a major substantive breakthrough. The first deep drilling of China's rock gold exploration, with a depth of 4006.17 meters, has created a precedent for deep exploration of metal minerals in China.
In the next step, we will continue to "go into the deep of the earth" and speed up the in-depth investigation of resources. The deep prospecting work of key mining areas will be carried out, and deep mineralization prediction, deep drilling verification and prospecting demonstration will be organized in the deep side of the prospective mining area to guide the mining enterprises in the area to follow up the exploration. On the other hand, strengthening the connection with major scientific and technological projects in the deep exploration of the Earth has rapidly transformed the

research results into concrete practices for guiding deep prospecting.

Practice Graphic:



Case 1-2: Application of three-dimensional modeling of JOYTON UAV tilt photography in mining industry

Practice Name: Application of three-dimensional modeling of JOYTON UAV tilt photography in mining industry

Implementing unit：China.

Practice Summary:

Mining is benefiting from the new technology of UAV in the process of acquiring data. UAVs are currently being used in many mines, and in the near future, drones are an essential configuration for the mining industry.

(1) Application range

1 Application in the investigation of mineral resources development status: mining location, land occupation, land use type, solid waste accumulation range and volume.

2. Application in disaster investigation caused by mineral resources development: including ground subsidence range, length of ground crack, location of collapse pit, range of mountain collapse, location of collapse, location and volume of landslide, length of channel siltation (position) and range of coalfield (natural rock refuse pile, the tailings), etc.

3. Application in mine ecological environment information survey: the range of damaged land, damaged vegetation, water pollution, desertification, land reclamation and mine environmental treatment effects, digital mines, etc.

4. Application in landscape modeling of geological mine park: introduction of online three-dimensional scenic spots in geological parks and mine parks

5. Other applications: the regional geological surveys, soil surveys, emergency disaster management, etc.

(2) Application advantages in the mine environment

1. Mobile, flexible and secure

It's no need for special airport take-off and landing. It is suitable for application in topography and hilly and cloudy areas in the south and is direct access to on-site data and data in hazardous and harsh environments.

2. High resolution, multiple angles

The resolution is 2cm and the scale of the drawing is 1:500. It can be used to construct high-precision digital ground model and three-dimensional landscape map. It can obtain the texture information of the damaged land in the mine at low angle and make up for the occlusion in ordinary aerial photography.

3. Excellent performance

It can fly and shoot autonomously within the range of 50 meters to 1000 meters according to the scheduled route, and the flight altitude control accuracy reaches 10 meters.

4. Low cost
The cost of using sensors and aircraft is much lower than other aerial photography systems so the average unit and individual can afford to it; the data processing equipment is not highly demanding and the cost is low.

Practice Graphic:

Case 1-3: Intelligent unmanned mining changes the development pattern of the industry

Practice Name: Huangling Mining: Intelligent unmanned mining changes the development pattern of the industry

Implementing unit：China.

Practice Summary:

In the two years since the successful application of intelligent unmanned mining technology in Huangling Mining, the biggest change has been to eliminate the threat of various natural disasters in the past underground operations, to liberate coal mining workers from dangerous environments, and to subvert the traditional mining cognition of coal technology.

A set of data is used to illustrate the relationship between intelligence and production efficiency: from 19 people in the single-shift operation of intelligent work surface to 7 people, the annual labor cost saving is more than 8 million yuan. The "1.4 ~ 2.2 m" coal seam intelligent comprehensive mining equipment has greatly improved with monthly output of working is stable at 170,000 tons, and the working efficiency of mining is 133 tons/work; the "1.5-2.8 m" coal seam intelligent comprehensive mining equipment has a single-shift stable production capacity, the monthly output is stable at 230,000 tons, and the mining efficiency is 149 tons/work. Production efficiency increases by an average of 15% or more.

In the construction process of the intelligent working of medium-thick coal seam, the application of intelligent comprehensive mining working advanced support equipment technology achieves the first remote control of the front support ground and the ground 'one-button self-shift' control, the initial development of the work-plane robot intelligent inspection organization, the first to take the lead in applying the industrial 3.0 intelligent control system with the advantages of fast video transmission and remote control, strong compatibility, high adaptability, simple operation and practicality, which has clarified the major changes in the intelligent and ultra-low emission of the coal industry.

Now the comprehensive, full-process, all-time, multi-perspective mastery of the underground production dynamics has replaced the past team leaders to report the downhole production dynamics. The current remote intervention and advanced pre-control management have replaced the field management methods of the past relying on people, and the promotion and application of technology. A group of new generations of professional business skills and high-quality workforces have been generated, and production tasks are easily completed in a safer environment.

Practice Graphic:

Case 1-4: China first sea area natural gas hydrate test has been successful

Practice Name: China first sea area natural gas hydrate test has been successful

Implementing unit：China.

Practice Summary:

The drilling platform of this test mining technology service "Blue Whale I" is the semi-submersible drilling platform with the deepest drilling depth in the world, which is suitable for deep sea operations worldwide. Through nearly four months of experimental exploration and scientific research, some new achievements and understandings have been achieved. First, the sand control technology is advanced, the method is reliable, the function is continuously and effectively, and the gas production channel is in good condition. The second is to achieve innovation in many aspects such as the lifting method and remarkable effect of improving production. Third, the regulation of production capacity is stable and effective, the airflow is stable, and the duration has reached the requirements of productive test mining, laying a solid foundation for industrialization development. Fourth, there is no abnormal concentration of methane such as seawater and surrounding atmosphere, and the environment is free from pollution. Fifth, the wellbore and stratum are stable so no geological disasters have occurred. Safe and sustainable production has been achieved. Sixth, the advantages of trial mining theory, technology, engineering and equipment are constantly expanding.

The success of this trial is the first time in China and the world's first successful realization of the safe and controllable mining of muddy sand-type natural gas hydrates with more than 90% of the world's resources and the most difficult development. After nearly 20 years of unremitting efforts, China has achieved independent innovation in the theory, technology, engineering and equipment of natural gas hydrate exploration and development, and achieved a historic breakthrough. The significant achievements in mastering key technologies such as deep sea entry, exploration and development have important and far-reaching effects, promoting energy production and consumption revolution.

Practice Graphic:

Case 1-5: LHD autonomous navigation system

Practice Name: LHD autonomous navigation system

Innovation in the Chilean Mining Industry with local scientific and technological capacities.

Implementing unit：Advanced Mining Technology Centre of Chile (AMTC).

Practice Summary:

Mining Industry in Chile - The Challenge: Deep underground operations as well as small and medium size mining companies have no access to high tech due to high costs and high operation risk of the mining personnel exposed to fatal accidents.

Main Achievement:

Autonomous navigator technology has developed together with the company GHH, implemented and tested in medium size mining company in Chile with a more affordable technology.

Increase productivity, improving the extraction process of ore, since it eliminates the inefficiency that occurs when switching from manual operation to remote control, which increases production by approximately 30% -50%.

Reduce the exposure of miners to dangerous work environment, in which miners are exposed to work in conditions of high concentration of dust in suspension and gases from the combustion of LHD engines.

Reduce accidents due to the system allow the operator to be removed from the (hazardous) extraction zone and taken to a control room, outside the mine or in a secure area, where the possibility of suffering an accident, even fatal and of contracting an occupational disease such as silicosis, is practically reduced to zero.

Practice Graphic:

Case 1-6: The case of Graphite mine and Refuse landfill exploration

Practice Name: Semi-airborne transient electromagnetic method

—— The case of Graphite mine and Refuse landfill exploration

Implementing unit：Chengdu University of Technology，China.

Practice Summary:

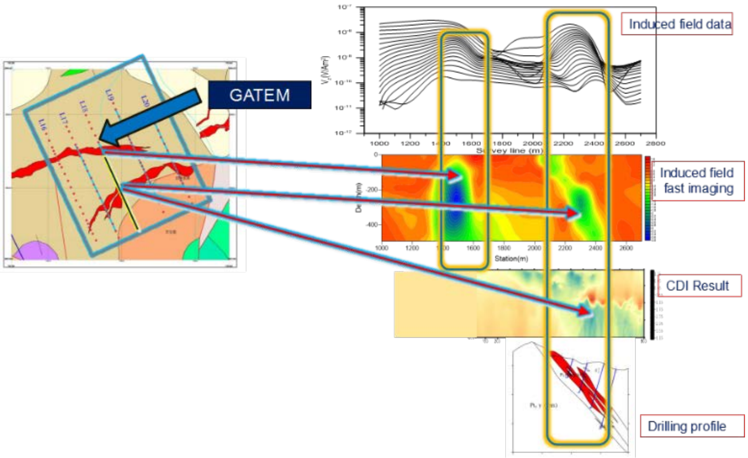
Semi-Airborne Transient Electromagnetic (SATEM) or Ground-Airborne Transient Electromagnetic (GATEM) used a large-moment grounded electrical source as a transmitter and towed a magnetic sensor through the air as a receiver.

Field case: Exploration in Known Graphite Mine

“Region1” contains two known graphite mineralized belt distributed in the south and north, respectively as the GATEM experiments in this area. The measured induced field data induces that fast imaging and CDI result and drilling profile form “Line-18” have good correspondence. It shows that the response of the mineral veins is prominent and the details of aviation electromagnetic are obvious. It is indicated that this method is suitable for the evaluation of mineral resources in large area rapidly.

This research is supported by the project of “Research and development of helicopter airborne electromagnetic detection data processing and interpretation software system (2017YFC0601806)” of key research and development projects of China.

Practice Graphic:



Case 1-7: Yili ISL Mine Practice

Practice Name: Development of Green Uranium Mine in China
——Yili ISL Mine Practice

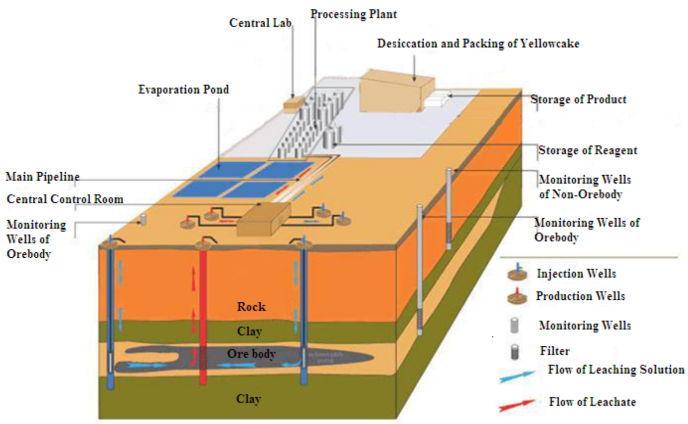
Implementing unit：China Uranium Corp. Ltd (CNUC)/CNNC, China.

Practice Summary:
ISL: underground leaching and leachates treatment.
To carry out the five development ideas of “Innovation, Coordination, Green, Open and Sharing” put forward by the government.
To implement the new concept of “Safety and Environmental Protection Benchmark, the Benchmark for Local Development, Enterprises and the Benchmark”put forward by CNNC.
To follow the uranium industry in China proposed the “New Model, New Standards, New Image, New Benefits" of the new ideas.
The project construction contents include: well site, hydrometallurgical plant, living quarters and power-assisted area.

(1) lower U grade for mining (0.01％) (conventional method requires the lowest grade 0.05%);

2.Recovery rate can be up to>90％;

(2) Less mining procedures, short working flow, easy to operate, low capital cost, high productivity, high degree of automation and low production cost;
(3) Notable economic, social, environmental and safety benefits.
In contrast with conventional mining, ISL is beyond comparison in environmental protection.
Practice Graphic:



Case 1-8: Tijuana. Lead and copper grit production plant

Practice Name: Environmental protection by remediation of contaminated soils
——Tijuana. Lead and copper grit production plant

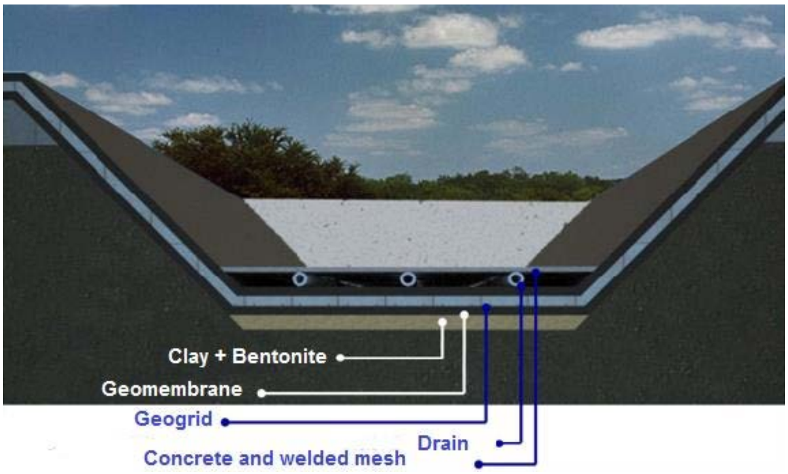
Implementing unit：Mexico

Practice Summary:
This land is contaminated by metals and derivatives of a industrial plant located in Tijuana, Baja California, dedicated to the refining of lead and copper grit production from waste, mainly automotive batteries. It is estimated that there is a volume of 20,000 tons of soil contaminated with lead and other toxic substances, such as arsenic, cadmium and antimony.
The stabilization cell technique is used. Encapsulate contaminants in their environment through physical or chemical treatments, instead of removing them. This way the mobility of dangerous substances is eliminated. This technology can be used

in conjunction with the installation of multilayer covers to provide additional protection and prevent vertical infiltration of water into the stabilized material package.

In October 2008, the Government of the State of Baja California handed over the land that had already been remediated to the Otay Mesa Industries Association (AIMO), with the purpose of using it as a sports center. After the delivery of the remediated land, sports and recreation courts were built for the inhabitants and workers of the Otay industrial zone. On January 28, 2009, an event was held to celebrate the cleanup and revitalization of the Metals and Derivatives site.

Practice Graphic:



Case 1-9: Study on the reduction, resources utilization, pollution control and environmental management of high risk scattered metal waste disposal

Practice Name: Study on the reduction, resources utilization, pollution control and environmental management of high risk scattered metal waste disposal.

Implementing unit：China University of Geosciences (Beijing)，China.

Practice Summary:

South west of China, like Hechi, belongs to Karst landform, which has many underground solution cavities and abundant underground water resources, many of them are connected to the local water system.
In Hechi, large-scale mining began in the early 1980s, and the number of mines reached 676 during the peak period. Many years of mining have resulted in 71 tailings ponds.
To sustainable mining industry, we must conduct scientific research and technology development for the cost-effective sustainable remediation of contaminated sites by means of geochemical and biotechnological methods.

（1）Remediation technology based on five-layer-cover strong-reduction stabilization and mineralization.

（2）Remediation technology based on In-situ biological mineralization.

（3）Recycling non-ferrous metal mine wastes with a new resourcing and reducing filling technology.

（4）Recycling municipal solid waste incineration fly ash with a new resourcing and reducing filling technology.

（5）A new method of biofilm treatment and recycle the wastewater from floatation of polymetallic sulfide ore using with ozone efficient strain packing.

（6）In situ microorganism immobilization technology of heavy metal contamination in river sediment.

（7）Engineering technology of bio-metallurgy from low-grade copper sulfide ore.

Do the following: Resource utilization of mining solid waste such as tailings; Ecological restoration of contaminated soil in mining area; Tailings reservoir leachate and plant mine production wastewater treatment.
More favorable to Stable, green and sustainable mining production environment, the gradual improvement of the living environment around the mining sites.
Practice Graphic:

Case 1-10: A good mining practice promotion scheme

Practice Name: A good mining practice promotion scheme.

Implementing unit：Thailand

Practice Summary:

Thailand’s mining industry in 2017, production value 2,278 million USD, Nearly 40 types of minerals 554 active mines and quarries.

Main products: limestone for cement production (22%), limestone for aggregate (24%), and lignite (20%).Direct employment 13,359, Mineral export value 379 million USD, mainly tin metal (42%) and gypsum (29%),Import value 1,948 million USD, mainly coal and coke products 75%.

The main problems are: Compliance；Environmental quality；Disturbance and

resistance of community；Safety and health inefficient resource use

The idea: supplement top-down management with bottom-up improvements; Good practice promotion scheme; A series of projects and activities; Implemented continuously (since 2004);Key actions.

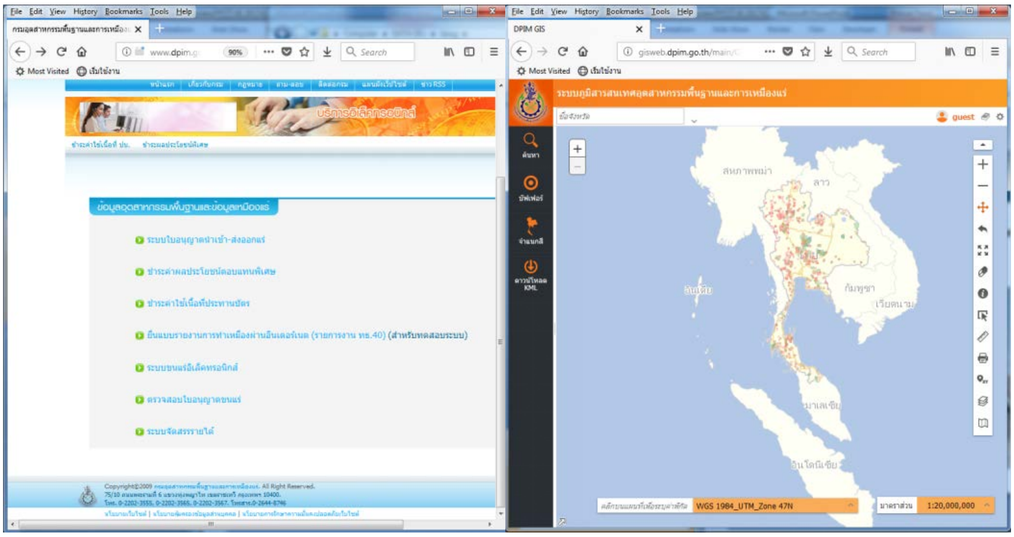
Policy implication:

(1)Both top-down and bottom-up efforts: Rules and regulations provide basic requirements; To corporate internal improvement and human development contribute to a higher-level of achievement.

(2)Roles of the government to stimulate, convince, and help.

(3)Actions are not a one-time event but continuous, systemic efforts.

Practice Graphic:



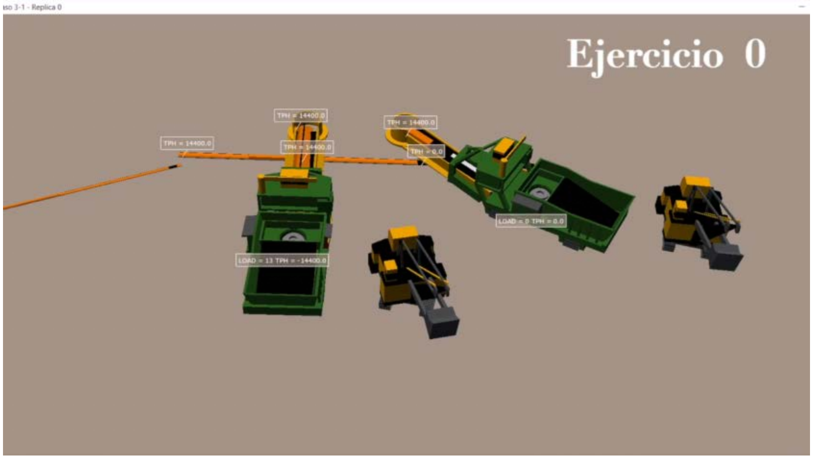
Case 1-11:DSIM（Simulation Software for material Transportation system of Open-pit Mining and Underground Mining）

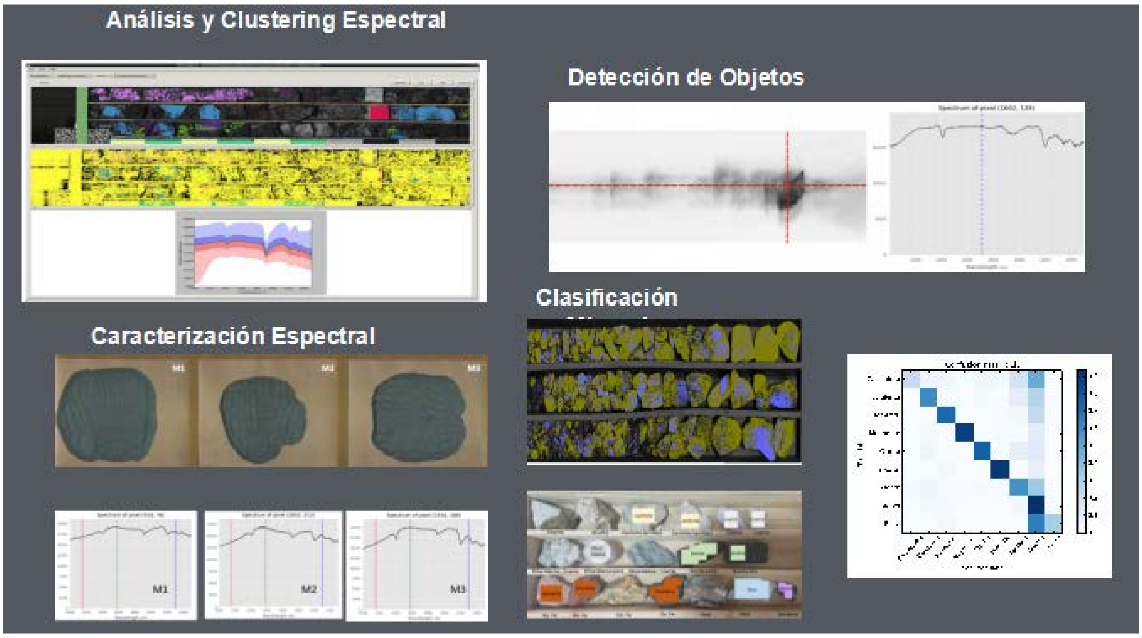
Practice Name: DSIM（Simulation Software for material Transportation system of Open-pit Mining and Underground Mining）.

Implementing unit：Advanced Mining Technology Centre of Chile (AMTC).

Practice Summary: There is a mentioning of software modeling called DSIM that is the successful case of technology development that was applied together with mining industry.

Practice Graphic:





Case 1-12: Deep Exploration Technologies CRC - Uncovering the future

Practice Name: Deep Exploration Technologies CRC - Uncovering the future

Implementing unit：Australia

Practice Summary:

Australia is on the verge of a solution to help reverse the trend of falling green fields mineral discoveries using cutting-edge technology developed by the Deep Exploration Technologies Cooperative Research Centre (DET CRC).

The mining industry has longed for the technology which could explore mineral deposits in this 80 percent of Australia where the minerals are hidden beneath barren surface rocks and where exploration can be very expensive and has not been very successful.

If Australia’s mining industry is to have a long-term future, we must improve our ability to make discoveries under barren cover. A key to this is making drilling cheaper.

The AutoSonde is the downhole component of this exciting new mineral exploration process. This technology enables explorers to measure the physical properties of the rocks intersected by the drill hole. The AutoSonde will measure properties such as the natural radioactivity and magnetism of the rocks which provide key information on the rocks being drilled.

The money saved by drilling rock quickly and having real-time data available at the site cannot be underestimated. This will provide Australia with the answer to future successful green fields mineral exploration.

Practice Graphic:

Case 1-13: GET Trakka – Bringing the smarts to mining

Practice Name: GET Trakka – Bringing the smarts to mining.

Implementing unit：Australia

Practice Summary:

Big miners are taking up new excavator sensor technology. GET Trakka's technology tackles the problem of teeth and other ground engaging tools (GET) breaking off excavator buckets during mining. Subject to extreme wear, GET teeth can last only days or weeks and, when broken, can jam-up a mine crusher resulting in millions of dollars of downtime.

GET Trakka uses Radio Frequency Identification sensors embedded in GET teeth to alert machine operators when teeth break off so they can quickly locate and extract them.

With some 1000 large open-cut mines worldwide, and most mines having about four to six diggers, there is enormous potential for the technology.

As well as detecting component breakage, the GET Trakka technology provides valuable data on, for example, the rate of digging and predicted wear, which can assist mining operators to establish the right maintenance and scheduling practices.

Practice Graphic:

Case 1-14: HMS Equipment – Engineering safe solutions

Practice Name: HMS Equipment – Engineering safe solutions

Implementing unit：Australia

Practice Summary:

A mini solution for costly clean-ups, while the mini loader has multiple potential uses, it was designed by HMS Equipment primarily to clear coal spillages under conveyor belts in mines.

These spillages can be costly and risky for workers to rectify because of the confined areas under belts and because belts often need to be shut down while a manual clean-up takes place, which can take up to three-hours and cost as much as half a million dollars.

Our machine is operated by one person using a remote control and it can work underneath operating belts, which means there can be zero downtime for conveyor belts and no production time lost due to spills.

HMS Equipment is actively targeting global markets and Australian Government commercialization assistance has helped it gain traction in the marketplace. An accelerating commercialization grant and expert advice backed the manufacture and export of a pilot mini loader into China in mid-2016.

Practice Graphic:

Case 1-15: Globaltech – Smart drilling breaks new ground

Practice Name: Globaltech – Smart drilling breaks new ground.

Implementing unit：Australia

Practice Summary:

New sensor technology lifts exploration drilling efficiency. Bringing down the cost and lifting the performance of drilling in mining exploration has long been the focus of research and development efforts, as its one of the most expensive parts of the exploration process.

In 2013, Globaltech began collaborating with CSIRO and the Australian Government's Deep Exploration Technologies Cooperative Research Centre to develop a reliable and robust sensor device that would measure the rate of penetration of mining exploration drill bits.

It allows important rate of penetration and geological comparisons to be calculated automatically via a mining operator's interface, meaning drillers can be informed when to change a drilling bit.

The user interface has clear digital readouts and a charted history feature for real-time and post-drilling analysis. The data is sent remotely back to HQ as a monitor for daily performance.

Globaltech has key rig manufacturers interested in its new technology and its Mark II ROP sensor device is expected to be launched in 2016.

The company has built important strategic partnerships with world-leading mining and drilling contractors, some of whom are now helping to validate the new ROP sensor system technology by facilitating trials.

Practice Graphic:

Case 1-16: Environminerals – Electro-winning ways.

Practice Name: Environminerals – Electro-winning ways.

Implementing unit：Australia

Practice Summary:

The resulting 'black box' technology is based on an enhanced electrowinning process. Electrowinning involves the recovery of metals from solution by passing a current through the solution.

The new enhanced technology has the potential to significantly reduce the high energy costs associated with existing extraction processes, meaning a higher percentage of minerals can be recovered from an ore solution in a cost-effective way.

Capable of being used to extract minerals such as gold, silver, copper, platinum, palladium and zinc, the technology presents multiple market opportunities in the cost-effective remediation of mine tailings dams and e-waste remediation.

The company is currently expanding and consolidating its IP portfolio and recently closed their first investment round which will allow them to establish lab facilities, purchase equipment and develop and prove out a small-scale commercial prototype, which will initially focus on the e-waste remediation market.

With the support of knowledgeable, experienced shareholders and an expanding advisory and research team, environmental minerals is poised to play a role in the re-emergence of South Australia as a smart manufacturing destination.

Practice Graphic:

Case 1-17: Heuch–solar powered refrigeration container keeps it cool, even off the grid

Practice Name: Heuch–solar powered refrigeration container keeps it cool, even off the grid

Implementing unit：Australia

Practice Summary:

Heuch's solar powered refrigeration solution is, in simple terms, a shipping container with solar panels on it. But the brilliance was in making it work.

Now, Heuch can commercialize its solar refrigeration product to the world for off-grid refrigeration opportunities, such as in isolated and remote communities and sites, mining and construction sites, defence and emergency response applications and environmentally-friendly applications.

Heuch used Accelerating Commercialization assistance to improve the manufacturing process to help create price parity with the product's diesel equivalent. The solar option price is now on par with diesel, so these containers can replace diesel-powered off-grid options and eliminate the need for fuel and generators.

Now, thanks to Heuch, a lack of power and infrastructure, or isolation, is no longer a barrier to refrigeration and other quality-of-life infrastructures.

Heuch's solar refrigeration container takes just 10 minutes to set up with no specialized equipment needed. If the container option is not practical to get into certain areas, there are flat pack solutions for assembly on site with most items less than 20kg.

The aircraft deployable 10-foot container option – or the Mobile Autonomous Refrigeration Utility (MARU) as Heuch named it – was on display at the 2017 Avalon Air Show in Victoria.

This version is ideal for urgent aid or disaster zone uses. The 20-foot and 40-foot container designs are ideal for larger and long term uses.

Practice Graphic:

Session 2: Policy Dimension of innovative and sustainable mining

Case 2-1: Green Mining Development in Altay Region, Xinjiang

Practice Name: Green Mining Development in Altay Region, Xinjiang to create a “two sustainable” demonstration area

Implementing unit：China.

Practice Summary:

The green mine is an effective measure to implement the ecological civilization construction proposed by the 18th Congress in China. It can effectively improve and optimize the level of regional mining development and take the road of sustainable development.

1. Precise positioning – to lay a solid foundation

In the protection of natural forests, glaciers, rivers, lakes, wetlands and grasslands, the Altay region has achieved remarkable results. Based on this, in 2014, Altay was successfully selected as a pilot demonstration of the construction of main functional areas.

Altay is aware of its positioning, and the precise positioning of the 〞green sustainable development path〞 has made the Altay people successful. Environmental protection is the foundation of life. It is constrained and the most inclusive benefit of the people. Without a good ecological environment, there is no other way to talk about it. The path of green sustainable development is the only choice.

2. **Focusing on exerting strength - promoting ecological environment improvement through project construction**

In 2014, the Altay region vigorously implemented the 〞Beautiful Village〞 project. Taking the project as the starting point and solving the problems one by one is a useful exploration in the ecological environment protection and construction of the Altay region. In 2014 alone, the Altay region proposed 53 key promotion projects. These projects cover all aspects of ecosystems such as natural forest and grassland restoration, lake and river conservation, and wetland conservation. At the same time, the corresponding projects of 〞beautiful village〞 project construction and mine environmental management have been comprehensively promoted.

The Altay region is rich in wind energy, solar energy and hydropower resources, and combines ecological environmental protection and construction work to actively promote the abandonment wind power generation project.

3. More measures are taken – working hard to build a “landscape-like place”

The Altay region has expanded its ecological advantages and proposed the development of a tourism-oriented service industry with the completion of the "land of fairyland"; based on the advantages of "green, ecological and organic", it develops modern agriculture and animal husbandry; based on the advantages of clean energy, it develops new industrialization. Arrows are created to create a “two sustainable” demonstration zone.

Practice Graphic:


Case 2-2: Fix-term position for chief mining engineer in City Concil, Ruoergai, China

Practice Name: Fix-term position for chief mining engineer in City Concil, Ruoergai, China

Implementing unit：China.

Practice Summary:

Zoige County is affiliated to the Aba Tibetan and Qiang Autonomous Prefecture. It is located on the northeastern edge of the Qinghai-Tibet Plateau. It is located in the northern part of Sichuan Province. It is the northern gate of Sichuan to the northwestern province. It has a deep mountain valley and steep terrain, with an altitude of 2,400 to 4,200 meters. A small ethnic minority gathering area is dominated by Tibetans (Tibetans account for 91% of the total population of the county), mainly farming and animal husbandry.

The deputy head of the Sichuan Institute of Nuclear Geology has been the former deputy secretary of the Zoige County Committee, in charge of ecological environment work.

1. We will carry forward the spirit of enterprising, study in the post, improve in the study, work in thinking, work in practice and improve in work; we will strictly observe the discipline to meet their own high requirements, establish a good image and be close to Zoige and love the Xiangyang District; we will strengthen the link between colleagues in Zoige County and local communication.

2. We will enter the grassroots level, understand the grassroots level, serve the grassroots, and improve the comprehensive capabilities of the cadres to create social harmony and share development results. We can understand the Zoige region from five aspects of economy, politics, culture, society and ecology.

3. In accordance with the support of the provincial party committee and the provincial government to help Aba's aid-aid work, the Tibetan Aid model of “first gathering, second lead and third catching” (to gather people's hearts, drive industrial development, promote people's livelihood improvement, grasp cooperation mechanism, grasp intellectual assistance, and grasp fund protection) is comprehensively implemented, which has made positive contributions to promoting the leap-forward development and long-term stability of Zoige County.

Practice Graphic:

Case 2-3: Sustainable Mining and the Need for Multi-Stakeholder Engagement-Observations from West Africa

Practice Name: Sustainable Mining and the Need for Multi-Stakeholder Engagement-Observations from West Africa

Implementing unit：Camborne School of Mines, University of Exeter

Practice Summary:

Sustainable mining elements Politics, society, economics, technology, social and physical environment A definition of sustainable mining "Evaluation and management of uncertainties and risks associated with the development of the earth's resources (Meech,2014) Miners can achieve sustainable development by: The simultaneous pursuit of sustained or enhanced: environmental quality, economic growth, and social justice. Sustainable development and sustainable mining should be about ensuring that future generations don't have to pay the prices for what we do today but that they will inherit a space in which they can happily live in.

The Impact of APEC Economies and the Challenge to Sustainable Mining: Presents challenges and opportunities; Trust issues; Maintaining SLO; What about APEC standards for sustainable mining growth in Africa?; Can the APEC study on innovative mining industry for sustainable growth be the platform to start thinking about innovative solution to improve perception and impact of mining activities from APEC economies in West Africa?

Benefit of Multi-Stakeholder Collaboration, Coordination can be a challenge but there are various benefits including: Access to a wider expertise and experiences; Build

stronger collaboration; Address capacity gaps; Promote economic growth; Find holistic solutions; Present more opportunities for sustainable mining
In Conclusion
• Education remains a key challenge to sustainable mining in WA
• Improve access to resources
• Encourage local and international stakeholder collaboration
• Gender inclusion is key
• Sustainable mining is not impossible; it requires strong commitment and collaboration from stakeholders and improved mining education coupled with relevant resources.
Practice Graphic:

Case 2-4: Innovation and Sustainability of Australia's Resources Sector

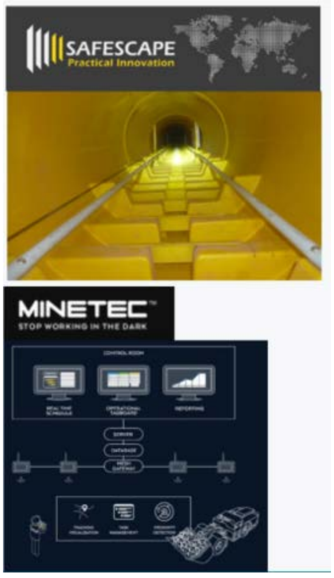
Practice Name: Innovation and Sustainability of Australia's Resources Sector.

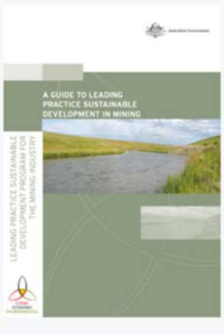
Implementing unit： Australia.

Practice Summary:
Division of responsibilities of Australia's Resources Sector:
>The Australia Government: Economic and International Scope.
>State and Territory governments: State and Territory Scope.
>Local government: Local Scope.
Specialized Australian METS companies include: Construction; Professional and technical services; Technical equipment manufacturing; Contract mining (including exploration); Transport services; Basic equipment manufacturing; Wholesale trade; ICT and Other services.
Leading practice sustainable development program: the leading practice sustainable development program (LPSDP) for the mining industry was established to promote sustainable mining practices.
The program developed a series of handbooks which provide mining managers, communities and regulators with information on leading practice approaches to mining management.
The handbooks are part of the Australia Government's aid for trade objectives which aim to reduce poverty and lift living standards through sustainable economic growth.

The 17 book series has provided an opportunity for Australia to further demonstrate how its expertise can benefit developing economies in their capacity to improve:
>minerals exploration and development;
>mining education and training;
>mine site environmental management;
>collaboration with local indigenous communities;
>the provision of mining equipment and technology services.
The handbooks have been shared with developing economies in the Indo-Pacific and Africa and translated into 8 selected foreign languages including Mandarin.

Practice Graphic:





Scan the QR code to download the handbooks.

Scan the QR code to download the Mandarin version.

Case 2-5: Chilean Strategy for Productive Development and Innovation in Mining Sector

Practice Name: Chilean Strategy for Productive Development and Innovation in Mining Sector.

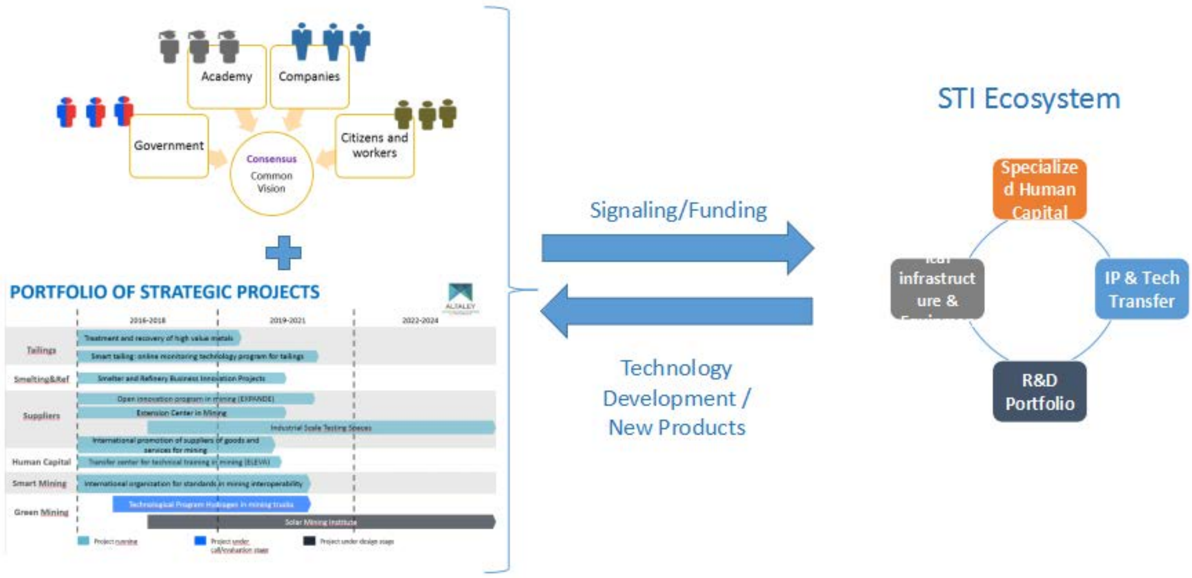
Implementing unit：CORFO - Chilean Economic Development Agency.

Practice Summary:

Corfo's today mission is to improve the competitiveness and the productive diversification of the economy by encouraging investment, innovation and entrepreneurship, strengthening in addition the human capital and technological

capabilities to achieve a sustainable and territorially balanced development.
Chile has a developed a technology based mining industry that addresses productivity challenges with a robust collaborative innovation ecosystem with the industry, suppliers, R&D and Public Sector.
Tailings: source of scarce and high value minerals.
Promoting a secondary mining industry from Tailings.
Consumer electronics, aeronautic industry and electro mobility require minerals that are very scarce in earth (Ga, Re, Ge, Co, rare earths, etc).
Tailings represent an opportunity: 2 R&D Consortia supported by Corfo are developing strategies and technologies for recovering value from tailings. In Chile, there are up to 400 tailings deposits (closed and operating) ~ 1 billion tons are produced annually.
A preliminary analysis shows 20% of them could be re-processed to extract the remanent Copper and Molybdenum, as well as high value minerals

Practice Graphic:



Case 2-6: Green Exploration in Zoige Polymetallic deposit

Practice Name: Green Exploration in Zoige Polymetallic deposit。

Implementing unit: Sichuan Institute of Nuclear Geology，China.

Practice Summary:
The uranium mine in the Zoige uranium field is rich in reserves and is the largest carbon-silica mudstone-type uranium field in western China. The Zoige uranium field was officially listed in the “358” prospecting breakthrough strategic action in 2012, and was listed as a domestic integrated exploration area by the Ministry of Land and Resources in the same year.

The first round of geological work in the area began in 1959 and lasted until the early 1990s. The second round of geological exploration was restarted in 2005 by the Sichuan Institute of Nuclear Geology. After several decades of efforts, 2 large uranium deposits and 2 small uranium deposits were implemented.

In order to carry out the integrated exploration, we have innovated our work concept, boldly explored and overcome difficulties, and done the following work:

1. Actively striving for economic policy support, serving local economic construction, and living in harmony with local aborigines;
2. Adhering to green exploration, actively exploring new exploration methods, and promoting advanced production processes;
3. Adhering to technological innovation.

Sichuan Institute of Nuclear Geology actively takes advantage of economic policies. It vigorously promotes green exploration in the region, maximally protecting the ecological environment from geological exploration, and on the other hand, it actively carries out various forms of communication and interaction with local governments and aborigines, enhancing mutual understanding and strengthening friendship.

Practice Graphic:

Case 2-7: The mineral policy 2

Practice Name: Mining policies in Malaysia–The mineral policy 2.

Implementing unit: Malaysia

Practice Summary:

Mining legislation has been introduced in Malaysia since 19th century. Main concern was based on the conflict of interest that arose between mining, forestry and agriculture.

The objectives of domestic mineral policy 2:

To ensure the sustainable development and optimum utilization of mineral resources;

To promote environmental stewardship that will ensure the domestic mineral resources are developed in an environmentally sound, responsible and sustainable manner;

To enhance the mineral sector's competitiveness and advancement in the global arena;

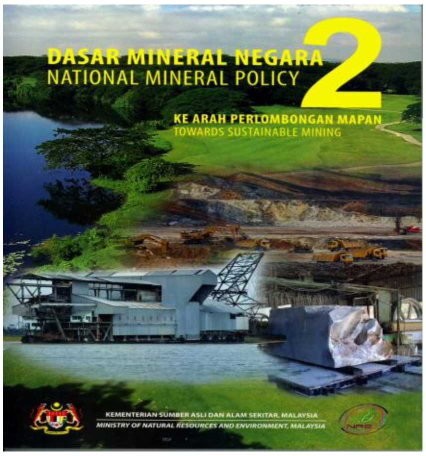
To enhance the use of local minerals and promote the further development of mineral-based products;

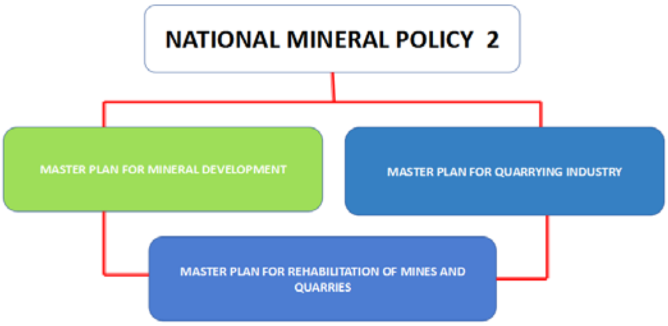
To encourage the recovery, recycling and reuse of metals and minerals.

Under NMP2, NRE formulated two master plans and one sub-master plan: To carry out the Master Plan for Mineral Development; Master Plan for Quarrying Industry Development; and Master Plan For Rehabilitation Of Mines And Quarries. Identified action plans 2011/2012 and onwards, Formation of Steering and Technical Committees, Formation of Task Force/Working Groups.

It is the Economy's aspiration to ensure that the Economy's mineral industry will grow in a sustainable manner prospering the Economy's development through the enhancement of the mineral industry's competitiveness at the regional and global level.

Practice Graphic:





Case 2-8: Corporate Social Responsibility for Mining operator

Practice Name: Corporate Social Responsibility for Mining operator.

Implementing unit：Department of Primary Industries and Mines, Thailand.

Practice Summary:

At present, the sustainable business requires three basic principles of development, which are based on ISO 26000: Economy; Social; Environment.

Mining industry often suffers from environmental problems such as vibration, noise, dust and pollution from mining. This caused complaints from the surrounding community.

Department of Primary Industries and Mines recognizes such probleMs The CSR-DPIM initiative has been implemented with the introduction of ISO 26000. In order to make the organization sustainable development, this project was initiated in 2009, but the budget was set up in 2010 and the consultant was hired. The consultant was Management System Certification Institute in Thailand (MASCI). The institute is well-known for its expertise in social responsibility.

(1) To implement social responsibility standards.

(2) To create the mining operators network, in exchange for knowledge, experience, expertise, social responsibility, Social and Community Activities.

(3)To encourage the mining operator to make a report on sustainable development; To show CSR results to all stakeholders consistently.

The CSR DPIM Activities: The mining operators joined the csr-dpim project are required to do plans for 3 main activities: The activities plan for the environment;

The activities plan for the stakeholders; the activities plan for the communities.

Practice Graphic:

Case 2-9: Innovative Mining Industry for Sustainable Growth: Malaysia's Effort through Higher Education

Practice Name: Innovative Mining Industry for Sustainable Growth: Malaysia's Effort Through Higher Education.

Implementing unit: School of Materials and Mineral Resources Engineering, Universities Sains Malaysia.

Practice Summary:

Talent management with perspective to the market's supply and demand. Academic program must incorporate excellent training pertaining to the mining industry (e.g., accredited by the Board of Engineers, Malaysia, complying to the Washington Accord or by MQA).

- Mining Engineering (Mineral Resources Engineering).
- Other related programs (Geology, Geophysics, Environment etc.)

Mineral Resources Engineering is run on OBE (clearer attainable knowledge). More focus in HSE, ethics and end-stream. Extra certification upon graduation (Shotfirer's, Simulation and Modelling tools, HSE training and certification, initial courses Close links between the industry, the government and HLIs through 'translational research'.Mineral Resources Engineering program aims for consultancies/testing works with value RM 250k per annum. Research grants to the program and related mining research is in excess of RM 1 mil at economic level. Aims are always to be a combined RM 500k per year for mining related research. Publications have been healthy (hydrometallurgy and pyrometallurgy; ore characterization; geology-based; mineral processing, etc.) for Chartered and Professional Engineer qualifications).

Practice Graphic:

Session 3：Development Dimension of innovative and sustainable mining

Case 3-1: Sichuan Qianwei Jiayang Mine Park

Practice Name: Sichuan Qianwei Jiayang Mine Park

Implementing unit：China.

Practice Summary:

The mine park, based on the display of human mining heritage landscape, reflects the historical connotation of mining development and possessing research value. The Jiayang coal mine, with a history of more than 70 years, has deposited rich industrial relics and human history in the passing of the years. The historical mine, with distinctive features, reasonable planning and supporting facilities and the natural scenic spots, are rich in knowledge, participation, experience, integrate cultural tourism, eco-tourism and heritage tourism.

The mining area was built in the 1938 during Anti-Japanese War, with a history of 70 years. As jiayang mining area is far from the city and belongs to the society of mining enterprise, it has been a systematic independent mining area in the long-term historical development of the mining area. Since 2006, in order to change the predicament and combine its own resource advantages, Jiayang mining area has determined the transformation goal of developing industrial heritage tourism in mining areas, and combined the protection of industrial heritage with the development of industrial cultural tourism as a highlight in the transformation planning of mining areas. The transformation plan of Jiayang mining area, lead by the mining enterprises, takes the opportunity of protecting the industrial heritage - "Jiayang Steam Train", and actively organize and mobilize various forces to compile relevant protection and utilization plans. Its mine tourism planning has become a model, and a model for joint construction of enterprises, localities and economies.

The Jiayang train is the only passenger steam train that is still operating normally in China even the world. It has the name of "living fossil of the industrial revolution" and the "out of print landscape of the industrial revolution", which is even more precious than the giant panda.

Practice Graphic:


Case 3-2: Metallurgical Complex in San Luis Potosí

Practice Name: An Innovation Example of Soil Remediation at I.M.M.S.A.
——Metallurgical Complex in San Luis Potosí.

Implementing unit：Sichuan Institute of Nuclear Geology，China.

Practice Summary:

The IMMSA Metallurgical Complex is located in the state of San Luis Potosí on the outskirts of the state capital. This complex consists of four metallurgical plants:

Arsenic、Copper、Lead、Zinc (still in operation).

During the period 1892 to 2010, the lead, copper and arsenic plants owned by Industrial Minera México, S.A. of C.V. (IMMSA), occupied an area of 440 hectares, where metallurgical waste was generated that affected the soil of the property. Over the years, the waste was dispersed windward to the nearest areas causing the soils to have a higher concentration of potentially toxic elements. As a result, efforts have been made to reduce concentrations of contaminants by successfully rehabilitating and recovering IMMSA soils.

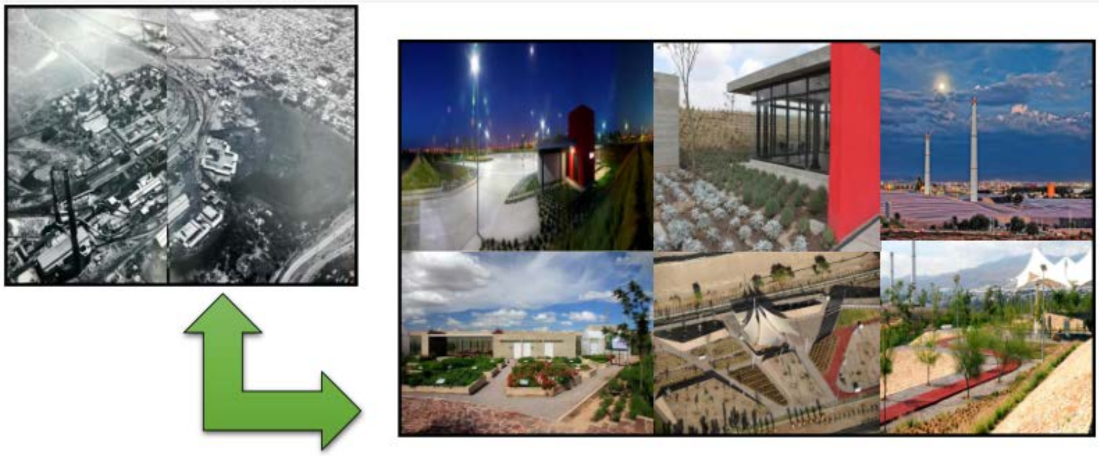
General strategy:

STAGE1: Studies for the location, design and construction process of two confinements in stable geological formation.

STAGE2: Characterization of the environmental damage.

STAGE3: Strategic plan. Development of remediation actions: Final disposal of soil contaminated with heavy metals (North confinement). Final disposal of soil contaminated with petroleum products. This remediation of 193 hectares impacted by metals, as well as the works for the physical stabilization and coating of 30 hectares of smelting slag is world class innovation procedure, in which IMMSA invested 55 million dollars. It exceeds the traditional standards for the recovery of contaminatedsoils by mining activity,

Practice Graphic:



Case 3-3: A Case Study for the Preservation and Development of Mine Heritage

Practice Name: Gold Museum: A Case Study for the Preservation and Development of Mine Heritage.

Implementing unit：Gold Museum, Chinese Taipei.

Practice Summary:

The First Mine Mountain of Noble Metals in East Asia, keeps a complete preservation of the precious nature, mining sites, landscape features, historical memories and cultural assets of the Jinguashi region.
Ecomuseum: Hugues de Varine & Georges Henri Riviere
Jinguashi: Mine industry / community / residents / advanced facilities
→a Self-sufficiency community
The planning of Gold Museum: Community; Preservation mining history; Develop local economic.

First Step：Local government; Preparatory group; Investigation of Mine Facilities;

Restoration buildings in core area, for administration, education, and display (before 2005).
Second Step: External Resources. Outsourcing: Hotels, Catering, transportations and so on; Construct 2 years (before 2007); Operate 20 years.
Museum self-employed and Cooperation with residents, in catering.
The World Heritage Convention“Efficient manage system need all stakeholders involved, especially local community”, Take control the huge change in mine landscape, Tourism vs heritage vs community, Work in cooperation to protect heritage.
Education, as a center of preservation, education and promotion of mine heritage
Access to the culture.

Practice Graphic:


Case 3-4: Strategy of the rational mineral resources development of the central black soil region, russia

Practice Name: Strategy of the rational mineral resources development of the central black soil region, Russia.

Implementing unit：Russia

Practice Summary:

The territory of the Central Black Soil region occupies about 1.5 % (192.4 thousand km2) of the territory of Russia, where about 6 % of the population (9 million people). The Central Black Soil region is an area of intensive development of agriculture (table).

Mineral resources have an important place in the overall structure of nature management in the Central Black Soil region. Very important for the region are ferrous metallurgy, and the construction industry. The autotrophic components of the biosphere (soil, forest, water and biological resources) are subjected to a strong anthropogenic impact. On the territory of the Central Black Earth region there are zones of radioactive contamination associated with the accident at the Chernobyl nuclear power plant.

The strategy of the mineral resources management determines the creation of conditions for a effective use of them, ensuring an optimal level of their reproduction, protection and consumption, aimed at improving the living standards of people. To solve these problems, an integrated and systematic approach to regulating subsurface using is needed. It assumes the analysis and synthesis of information about all mineral resources types, the elaboration of possible scenarios of their development in specific areas, study and programs preparation of protection and reproduction of resources. The main element of market mechanisms for environmental management is the assessment and forecast of the development of the mineral resource potential of administrative units.

Practice Graphic:

Case 3-5: Green Mines Construction in China

Practice Name: Green Mines Construction in China.

Implementing unit：China

Practice Summary:

China is among the few economies with abundant mineral resources. A complete varieties of mineral resources with abundant reserve. 173 varieties of mineral resources discovered, 159 proved reserves. More or less all types of metallic minerals that have been discovered worldwide have been proven to have certain reserves in China.

Rapid economic development over the past 30 years resulted in huge demand for mineral resources. Some mining companies, especially small scale companies pay less attention on environmental protection and resulted in environment degradation.

A Green Mines System: "governments guide, companies playing key roles, standards leading run, policy support, mechanism innovation, strengthen monitoring, implementing accountability, stimulate viability"

Various stakeholders are actively engaged in the construction. Some innovative mechanisms are established. For example Zhongguanchun Green Mine Industry Coalition. Under the guidance of Ministry of Land and Resources (now the Ministry of Natural Resources), more than 30 units comprising of research agencies, universities, mining companies launched the innovative coalition and registered as the only green mines innovative coalition. Now it has 160 members and 120 experts.

More efforts are undergoing at different levels. A communication and coordination mechanism will be established between various government departments to allow the relevant departments of environmental protection and safety supervision to review the plans for the construction of green mines, process supervision and engineering.

Practice Graphic:




Case 3-6:"LOS JALES" Ecological Papk & Touristic Mine

Practice Name: "LOS JALES" Ecological Papk & Touristic Mine, FRESNILLO, ZACATECAS.

Implementing unit：Mexico

Practice Summary:

Mining Industry in Mexico has been active since the 16th century, that is, almost for 500 years with influence in the society and the economic evolution as the economy is among the world's largest metal producers.

Advances in technology and the social and governmental concern, the mining impacts to the surrounding environment are actually avoidable.

Mining can become sustainable by developing and integrating practices that reduce the impact to the environment. Such practices include: reducing water and energy consumption; minimizing land disturbance and waste production; preventing soil, water, and air pollution at mine sites and, conducting successful mine closure and reclamation activities.

"Los Jales" ecological park was established in 2004, over a tail dam in the "Proaño mine". It became a public and touristic place with an extended area of 30 hectares.

Amenities; Eight suspension bridges; Sanctuary for mammals, birds and reptiles lakes, paths and open areas for physical exercise Touristic mine.
A visit to an underground mine is available, as well as to the top of Cerro Proaño, (Proaño Hill) it consists of a guided tour in 450 meters and 500 meters on ramp, where is described the evolution of mining since the age of the Spanish conquest to the present with a duration of one hour.
Mine closure plans are specific to each mine, and include details on how the mining company will close the mine site, how environmental protection will be achieved, and how the site will be returned to an acceptable state for a pre-arranged land use. Within the closure program are contemplated restoration activities, flora and fauna protection, waste management, environmental monitoring, reforestation, maintenance of organisms in nurseries, among others.

Practice Graphic:





Case 3-7: Developing world first power infrastructure for the north

Practice Name: Genex Power: Developing world first power infrastructure for the north

Implementing unit：Australia

Practice Summary:

The project is transforming a remote site, which was once Australia's largest gold mine, into a 21st century renewable energy hub. It will use the valuable infrastructure left behind after the mine's closure and the region's high solar radiation levels to supply the economic electricity grid via Townsville.
By 2021, the Kidston facility will be using around 3.5 million solar panels and two water reservoirs to sustainably generate, store and transmit reliable and affordable power.
The project will assist the supply of affordable and reliable power in the north Queensland region and into the economic grid. Their will be able to provide reliable,

renewable energy on tap during peak demand periods, supressing power prices and stabilising the grid. It will also encourage other renewable energy projects to start up nearby and will open up opportunities for other businesses.

The legacy of the old gold mine to the Kidston project includes an existing airstrip, good road access to Townsville and Cairns, onsite accommodation, electricity transmission lines into the economic grid via Townsville and permits and regulatory approvals.

The jewel in the project's crown is two 300-metre-deep disused mine pits situated in very stable, hard rock. They will be used for pumped hydro, creating a giant 'water battery' so that the solar power generated when it is sunny can be stored and supplied to the economic grid during peak demand periods.

Practice Graphic:

Part Four: List of Enabling Technologies and Policies

1. Green mining

Green exploration is guided by the concept of green development by means of scientific management and advanced technology. It aims to generate both environmental and economic benefits, and minimize the environmental impact of geological exploration.

(1) Green mining develops in China while Uranium Mine and Green Mining develop in Altay Region, Xinjiang, China. The five development conceptions of “Innovation, Coordination, Green, Open and Sharing” are put forward by the government, with the implementation of the new concept of “Safety and Environmental Protection Benchmark, the Benchmark for Local Development, Enterprises and the Benchmark”. The new concept is put forward by CNNC and follows the uranium industry in China proposing the new ideas of “New Model, New Standards, New Image, and New Benefits”.

(2) The strategy of the rational mineral resources development of the central black soil region in Russia determines the creation of conditions for the effective use of them, ensuring an optimal level of their reproduction, protection and consumption and aiming at improving the living standards of people. An integrated and systematic approach is applied to regulate subsurface usage. It assumes the analysis and synthesis of the information about all mineral resources types, the elaboration of possible scenarios of their development in specific areas, and the study and programs preparation of protection and reproduction of resources. The main element of market mechanisms of environmental management is the assessment and forecast of the development of the mineral resource potential of administrative units.

(3) Green Mines Construction in China

The Green Mines System: "governments guiding, companies playing key roles, standards leading, policy supporting, mechanism innovating, monitoring strengthening, implementing accountability, and stimulating viability" is established. Various stakeholders are actively engaged in the construction, establishing some innovative mechanisMs

2. Deep mining

Along with the increase in the exploitation of shallow mineral resources, metal mines especially, are gradually moving towards deep mining. However, the deep mining is face with many environmental and technical challenges.

(1) Deep Exploration Technologies is from Australia. The auto sonde is the down hole component of the exciting new mineral exploration process. The technology enables explorers to measure the physical properties of the rocks intersected by the drill hole and it will measure properties such as the natural radioactivity and magnetism of the rocks, which provides key information on the rocks being drilled and will provide

Australia with the answer to future successful green field mineral exploration.

(2) Deep exploration technology of gold mine is applied in Jiaodong area, Shandong Province in China. Since the implementation of the prospecting breakthrough strategic action in 2011, the deep exploration of the gold mine in the Jiaodong area has achieved significant results, and a number of large and extra large gold mines have been identified. In other words, the gold exploration technology has achieved a major substantive breakthrough.
(3) The eophysical exploration is applied in China. Semi-Airborne Transient Electromagnetic (SATEM) or Ground-Airborne Transient Electromagnetic (GATEM) used a large-moment grounded electrical source as a transmitter and towed a magnetic sensor through the air as a receiver, which helps the deep exploration of sub-ground. This research is supported by the key research and development projects in China.
(4) Deep mining is one of the challenges for the mining development in Chile. Solutions include improvement and development of prospecting techniques, improvement and development of drilling technologies and knowledge integration from operations and projects.

3. Intelligent mining

Intelligent mining refers to intelligent and automated mining equipment as the core, high-speed, large-capacity, two-way integrated digital communication network as the carrier, intelligent design and production management software system as a platform, and intelligent monitoring and control for mine production objects and processes through real-time and dynamic control, which maximizes the safety, efficiency and economic benefits of mining.
(1)Three-dimensional modeling of JOYTON UAV tilt photography is applied in the field of mining industry, China, including the investigation of mineral resources development status, disaster investigation caused by mineral resources development, mine ecological environment information survey, landscape modeling of geological mine park and etc. With high resolution and multiple angles but low cost, it delivers excellent performance.
(2)Intelligent unmanned mining is applied in Huangling Ming, China. The biggest change is to eliminate the threat of various natural disasters in the past underground operations, to liberate coal mining workers from dangerous environments, and to subvert the traditional mining cognition of coal technology. Now the comprehensive, full-process, all-time, multi-perspective mastery of the underground production dynamics has replaced the past team leaders to report the down hole production dynamics. The current remote intervention and advanced pre-control management have replaced the field management methods of the past relying on people, and the promotion and application of technology. A group of new generations of professional business skills and high-quality workforces have been generated, and production tasks are easily completed in a safer environment.
(3) Radio Frequency Identification sensors technology brings the smarts to mining in Australia. Big miners are taking up new excavator sensor technology to tackle the

problems of teeth and other ground engaging tools breaking off excavator buckets during mining. With the use of Radio Frequency Identification sensors embedded in excavator teeth to alert machine operators when teeth break off, they can quickly locate and extract them. It also provides valuable data on, for example, the rate of digging and predicted wear, helping mining operators to establish the right maintenance and scheduling practices.

(4)Global tech-Smart drilling breaks new future for Australia. New sensor technology lifts exploration drilling efficiency. Lowering the cost and improving the performance of drilling in mining exploration has been the focus of research and development efforts for a long time as its one of the most expensive parts of the exploration process. The user interface has clear digital readouts and a charted history feature for real-time and post-drilling analysis. The data is sent remotely back to HQ as a monitor for daily performance.

(5) Chile, DSIM（Simulation Software for material Transportation system of Open-pit Mining and Underground Mining）is applied by AMTC. Software modeling called DSIM is the successful case of technology development applied together with mining industry.

4. New energy exploration

In response to global climate change, the world's energy transformation characterized by the replacement of fossil fuels with new energy is rapidly developing.

(1) China first sea area natural gas hydrate test is successful. The success of this trial is the first time in China and the world's first successful realization of the safe and controllable mining of muddy sand-type natural gas hydrates with more than 90% of the world's resources and the most difficult development. The significant achievements in mastering key technologies such as deep sea entry, exploration and development have important and far-reaching effects, promoting energy production and consumption revolution.

(2)Solar powered refrigeration container and even off the grid are applied in Australia. The company used Accelerating Commercialization assistance to improve the manufacturing process to help create price parity with the product’s diesel equivalent. The solar option price is now on par with diesel. Therefore, these containers can replace diesel-powered off-grid options and eliminate the need for fuel and generators. Now, thanks to this technology, the lack of power and infrastructure, or isolation, is no longer a barrier to refrigeration and other quality-of-life infrastructures.

(3)In October 2015, Chile's Ministry of Energy announced its "Roadmap to 2050: A Sustainable and Inclusive Strategy" planning that 19% of the domestic electricity is to be from solar energy, 23% from wind power and 29% from hydroelectric power. New energy exploration also includes biomass, hydro-power, geothermal and wind.

5. Tailings utilization

In the accumulated tailings in the past, there are many useful components that can now be extracted, and the remainder of the extraction can still be found for their availability. Some tailings in a tailings pond or tailings in a certain area being almost completely have the possibility of reused in the case of strong technical, economic and market demand.

(1) In Chile, tailings are source of scarce high value minerals, promoting a secondary mining industry. There are up to 400 tailings deposits (closed and operating) ~ 1 billion tons annual production, minimizing the impact of leakage and ensuring the stability of dumps. It controls of particulate matter and seals tailings dump.

(2)The Electro-winning is applied by Environ-minerals from Australia. With the support of knowledgeable, experienced shareholders and an expanding advisory and research team, environmental minerals is poised to play a significant role in the re-emergence of South Australia as a smart manufacturing destination.

Electro-winning involves the recovery of metals from solution via passing a current through the solution. The new enhanced technology has the potential to significantly reduce the high energy costs associated with existing extraction processes. In other words, a higher percentage of minerals can be recovered from an ore solution in a cost-effective way.

(3)Study on the reduction, resources utilization, pollution control and environmental management of high risk scattered metal waste disposal is carried out of China University of Geosciences (Beijing). It includes remediation technology based on five-layer-cover strong-reduction stabilization and mineralization, remediation technology based on In-situ biological mineralization, recycling non-ferrous metal mine wastes with a new resourcing and reducing filling technology, recycling municipal solid waste incineration fly ash with a new resourcing and reducing filling technology, engineering technology of bio-metallurgy from low-grade copper sulfide ore and other technologies. This study is more favorable to stable, green and sustainable mining production environment and the gradual improvement of the living environment around the mining sites.

6. Remediation

(1)The stabilization cell technique is used in Mexico. Encapsulate contaminants in their environment through physical or chemical treatments, instead of removing them. By this way, the mobility of dangerous substances is eliminated. This technology can be used in conjunction with the installation of multilayer covers to provide additional protection and prevent vertical infiltration of water into the stabilized material package.

(2)The general strategies of Metallurgical Complex in San Luis Potosí, Mexico are as follows:

STAGE1: Studying the location, design and construction process of two confinements in stable geological formation. STAGE2: Acquiring the characterization of the environmental damage. STAGE3: Strategic plan. To make the plan of remediation actions: the final disposal of soil contaminated with heavy metals (North confinement) and the final disposal of soil contaminated with petroleum products. It exceeds the traditional standards for the recovery of contaminated soils by mining activities.

7. Back-end reuse of mine mining

Combining the two themes of resource and environment, while deepening excavation of resources, expand the content of environmental ecology, such as mine parks, mine museums, mine tourism, and even mine science experience, turning waste into treasure.

(1)Gold Museum in Chinese Taipei.

The Preservation and Development of Mine Heritage is for administration, education, and display (before 2005). The External Resources is Outsourcing, which operates 20 years. The World Heritage Convention “Efficient management system needs all stakeholders involved, especially local community”. It controls the huge change in mine landscape, tourism and heritage and community. Cooperation is needed to protect heritage.

(2) “LOS JALES” Ecological Park & Touristic Mine, Mexico

“Los Jales” ecological park was established in 2004, located in the tail dam in the “Proaño mine”. It became a public and touristic place with an area of 30 hectares. An underground mine is available, as well as to the top of Cerro Proaño, (Proaño Hill) in a visit, including a guided tour in 450 meters and 500 meters on ramp, flora and fauna protection, waste management, environmental monitoring, reforestation, maintenance of organisms in nurseries and etc..

(3) The construction of Sichuan Qianwei Jiayang Mine Park, China

The mine park, based on the display of human mining heritage landscape, shows the historical connotation of mining development and possessing research value. Since 2006, in order to change the predicament and combine its own resource advantages, Jiayang mining area has determined the transformation goal of developing industrial heritage tourism in mining areas, and combined the protection of industrial heritage, with the development of industrial cultural tourism as a highlight in the transformation planning of mining areas. The transformation plan of Jiayang mining area is leaded by the mining enterprises, taking the opportunity of protecting the industrial heritage - "Jiayang Steam Train". Various forces are actively mobilized to compile relevant protection and utilization plans. Its mine tourism planning has become a model for joint construction of enterprises, localities and economies.

(4) The world first power infrastructure is developed in northern Australia.

The project is transforming a remote site, which was once Australia’s largest gold mine, into a 21st century renewable energy hub. It will use the valuable infrastructure left behind after the mine’s closure and the region’s high solar radiation levels to supply the domestic electricity grid via Townsville.

(5) The Chilean mining industry. Tailings are currently a major source of conflict between companies and communities: 47% of the tailings produced in local have complaints against them or some sort of conflict with the population. The increasing scarcity of water and space must be considered.

8. Mining safety and security

Engineering safe solutions and Equipment in Australia.

A mini solution for costly clean-ups with multiple potential uses is applied. It was

designed by HMS Equipment primarily to clear coal spillages under conveyor belts in mines. HMS Equipment is actively targeting global markets and Australian Government commercialization assistance has helped it gain traction in the marketplace.
(2)The LHD autonomous navigation system is applied by the Advanced Mining Technology Centre of Chile (AMTC). Autonomous navigator technology has developed, implemented and tested in medium size mining company in Chile, with a more affordable technology. It reduces the exposure of miners to dangerous work environment and reduces accidents.
(3) In Chile, the workplace safety and quality are improved and great progress is made in development of techniques to reduce direct intervention on the part of operators. The operators and maintenance workers, who are experts in automation and robotics, are trained in Technical Training Centers. Universities contribute to research, instrumentation and control.

9. Dialogue with the Residents and the Science Popularization Works

In the course of mining, residents issue is the common problem in member economies, and social acceptance of mining is the baseline for mining activity. The science popularization is an effective way to avoid its conflicts, the focus of which is not only on the technology itself, but in the explanation to the local people the whole project technology, the harmlessness of the project implementation itself, and the benefits that the project implementation can bring to the local community, to impact area beneficiaries communities receiving their due share of benefits, so that the people can accept the mining project in the local area, recognize and support the mining development.

10. Multi Collaboration

(1) Dialogue with local government
Sichuan Institute of Nuclear Geology actively takes advantage of domestic policies. It vigorously promotes green exploration in the region and maximally protecting the ecological environment from geological exploration. On the other hand, it actively carries out various forms of communication and interaction with local governments and aborigines, enhancing mutual understanding and strengthening friendship.
The strategy for Productive Development and Innovation in Mining Sector in Chile.
Chile has a developed technology, establishing a robust collaborative innovation ecosystem with the industry, suppliers, R&D and Public Sector on mining industry tot addresses productivity challenges.
(3) Multidisciplinary
Operating a mine is a multidisciplinary task that must be coordinated to be undertaken in a safe and effective way. The work teams that participate include, among others: geology, geo-technique, planning, topography, mine operations, maintenance, administration, services, and support in health, safety, the environment and quality, among consultants from diverse areas.

(4)Multi stakeholder engagement
Sustainable Mining and the Need for Multi-Stakeholder Engagement-Observations from West Africa. Sustainable mining elements Politics, society, economics, technology, social and physical environment A definition of sustainable mining “Evaluation and management of uncertainties and risks associated with the development of the earth’s resources (Meech,2014) Miners can achieve sustainable development by: The simultaneous pursuit of sustained or enhanced: environmental quality, economic growth, and social justice. Sustainable development and sustainable mining should be about ensuring that future generations don’t have to pay the prices for what we do today but that they will inherit a space in which they can happily live in.
(5)From the view PNG, mining development should target at inclusive growth, with a common goal based on shared value by all stakeholders so that at some stage during the life of mine, especially at end of mine life and the impact area landowning communities and often voiceless groups like women, youth and disabled.
(6) Thailand, Corporate Social Responsibility for Mining operator. At present, the sustainable business requires three basic principles of development, which are based on ISO 26000: Economy; Social; Environment.

11. Personnel development education works

(1) Innovative mining industry for sustainable growth through higher education: Talent management is with perspective to the market’s supply and demand. Academic program must incorporate excellent training pertaining to the mining industry.
(2) Technology think tank for mining.
(3) Focused in engineering schools, it supports the implementation of strategic plans to transform
their educational programs under international standards in the fields of applied R&D, technology transfer, innovation and entrepreneurship , lifting them into a World Class category.
(4) In Australia, The Leading Practice Sustainable Development Program for the mining industry was established to promote sustainable mining practices, which also developed a series of handbooks which provide mining managers, communities and regulators with information on leading practice approaches to mining management.

12. Platform

(1) Chile, Mining open innovation platform for supplier development. The establishment in Chile of International Centers of Excellence in R&D to carry out Research and Development, technology transfer and commercialization activities, in fields on the technological cutting edge, with high domestic and international economic impact, and that strengthen domestic R&D capabilities. The strengthening of networks for technical collaboration with public entities and sectoral initiatives for the monitoring of programs (reports, permits, regulations, etc.).
(2)A platform for inclusive sustainable growth in the Mining Industry in PNG,

13. Long term planning

With the integration of the global economy, the geological prospecting industry should be actively integrated into long term planning, like (1) the domestic “13th Five-Year Plan” in China, fully expand exchanges and cooperation with economies and regions along “The Road and Belt”, actively participate in the cooperative development projects of international energy and mineral resources.

(2)Chile’s development of mining pattern, 2035 roadmap, from factor-driven economy(1975 to 1985) to Investment-driven economy(1995 to 2015) to innovation-driven economy (to 2035)

(3) From Malaysia, Under NMP2, NRE formulated two master plans and one sub-master plan: To carry out the Master Plan for Mineral Development; Master Plan for Quarrying Industry Development; and Master Plan For Rehabilitation Of Mines And Quarries. Identified action plans 2011/2012 and onwards, Formation of Steering and Technical Committees, Formation of Task Force/Working Groups. It is the Economy’s aspiration to ensure that the Economy’s mineral industry will grow in a sustainable manner prospering the Economy’s development through the enhancement of the mineral industry’s competitiveness at the regional and global level.

(4) From Thailand, Corporate Social Responsibility for Mining operator, The activities plan for the environment; The activities plan for the stakeholders; the activities plan for the communities.

To implement social responsibility standards；To create the mining operators network, in exchange for knowledge, experience, expertise, social responsibility, Social and Community Activities；To encourage the mining operator to make a report on sustainable development

Part Five: The Policy Recommendations

Background:

The project is proposed by China and cosponsored by Australia, Chile, Chinese Taipei, Indonesia, Papua New Guinea, Peru, and Thailand, making the project approved by APEC PPSTI and MTF. Thanks to the representatives of the economies for attending this seminar and thanks to Sichuan Institute of Nuclear Geology for hosting this seminar.

At the “APEC Study on Innovative Mining Industry for Sustainable Growth” seminar, three sub-themes were focused: (1) the technology of innovation and sustainable mining; (2) the policy of innovation and sustainable mining; (3) and the development of innovation and sustainable mining. During the seminar, the participants have presented a number of constructive ideas and suggestions to contribute to APEC, including:

Policy Recommendation:

1. Accessible and Adaptable:

With the development of science and technology as well as technological innovation, more and more advanced and cutting-edge technologies or instruments are used in the mining industry. With great achievements, but high prices, long-term technical services, follow-up maintenance, device replacement and other issues are not the best for APEC economies, especially for the developing economies. It will be more suitable to learn from the successful experience and technology of other economies and improve and upgrade the technology according to the local conditions and mode of developing economies. For developing economies, practical and applicable technologies can be more viable than advanced cutting-edge technologies.

2. Environmentally friendly Mining:

The old path of the extensive mining economy at the expense of the environment has been unable to adapt the new requirements of the times. The environment friendly mine is an inevitable choice for mining development with rational development and utilization of resources, under the concept of “environmentally friendly use of resources”. Efficient exploration has become the trend of mining transformation and upgrading. At the same time, the environmentally friendly mining does need the support from government, including policy and financial. Moreover, only the environmentally friendly mining would make progress with the help of the innovative technology.

3. Mining Safety& Security:

Mining safety is not only to be supported by the advancement and improvement of technology, but also need all to be the help of perfect management system of the local government and organization. Personnel must have environmental awareness and safety awareness with related knowledge and raising awareness. Safety behavior should gradually transform from “passive after-awareness” to “active foresight”.

4. Public and Private Collaboration:

Mining is not just a mine, or just engineering, but it is an economic combination requiring the strong support and guidance of continuous communication among all. Personnel from mining industry should carry out short stays in local government agencies, or second front-line personnel to work in relevant state government agencies, or setting up a permanent dialogue between mining and government, always maintaining a high degree of understanding in line with the government's guiding development policy.

5. Dialogue with the Residents, the Science Popularization Works:

In the course of mining, residents issue is the common problem in member economies, social acceptance of mining is the baseline for mining activity. The science popularization is an effective way to avoid its conflicts, the focus of which is not only on the technology itself, but in the explanation to the local people the whole project technology, the harmlessness of the project implementation itself, and the benefits that the project implementation can bring to the local community, to impact area beneficiaries communities receiving their due share of benefits, so that the people can accept the mining project in the local area, recognize and support the mining development.

6. Women in Mining:

It is recommended that women are given fair and equal treatment opportunity in all aspects of mining form being an employee of the mine, especially in the work of government dialogue mechanism and science popularization in which women can give full play to their advantages, to ensure women as equal players in the industry.

7. More dialogue in Mining and cross-fora:

It is recommended that the need and interest in continuing to focus and pursue dialogue on Sustainable Mining especially in cross-fora, this project is just the beginning it should follow up with the subsequent dialogue, enhancing collaboration and take advantages of the synergies are key factor for the mining future.