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this issue contains...

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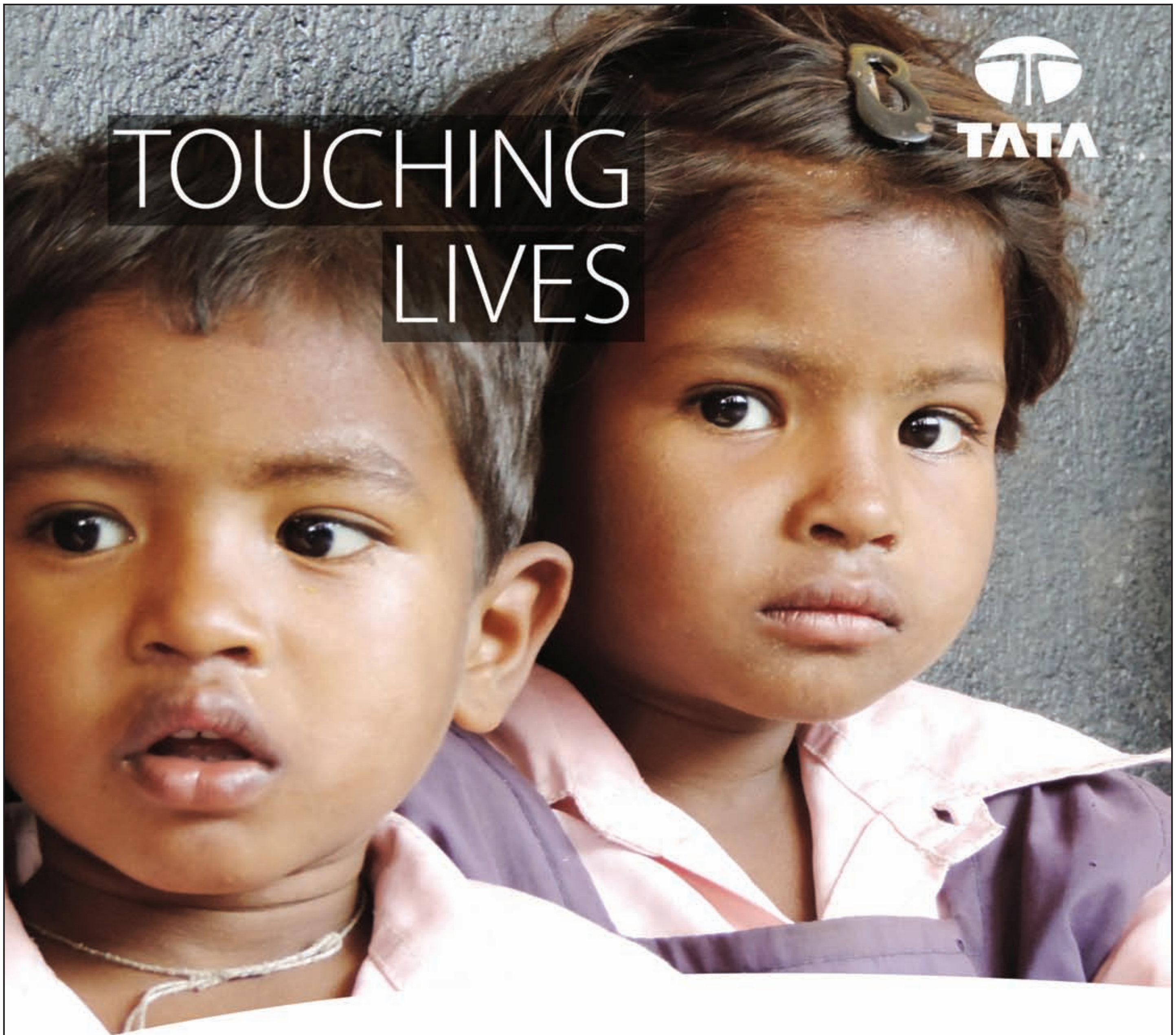
TOUCHING
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President's Message......

Dear Readers

Greetings!

India is one of the first countries in the world to address the importance of entrepreneurship development and the need to unleash entrepreneurial potential to achieve economic prosperity. With the Government taking initiatives to simplify Regulations towards ease of doing business, key changes have been announced in the recent past; viz., Amendments to the Companies Act, SEBI Regulations and Labour Laws; with the intent to help businesses navigate the challenges posed by the Covid-19 pandemic.

The Mines and Minerals (Development and Regulation) Amendment Bill, 2021 will do away with the distinction between the captive and non-captive mines, allow captive mines to sell up to 50% of the minerals excavated during the current year and will also help towards the auctioning of more mines. It will also allow the union government conduct auctions for those blocks wherein the “state governments face challenges in conducting auction or fail to conduct it," with the revenues accruing from such blocks going to the state government' exchequer. This bill is bound to revolutionise the Mining Sector.

I am glad to inform you that the Ministry of Railways has recently released the National Rail Plan. The document is highly detailed and clearly reflects the significant effort and comprehensive research that has been undertaken in its preparation. The document lays down a plan to steadily increase freight market share of Indian Railways from 28% at present to 44% by FY31. It also seeks to serve more passengers and attract them away from alternative modes of transportation. The overall long-term rail development plan has been stated and the deficiencies in the present rail infrastructure have been correctly identified. Furthermore, it identifies the future requirements, prioritises the projects and also evaluates the funding requirements and financing strategies.

I would like to congratulate the Barajamda Chapter, Bellary-Hospet Chapter, Kutch Local Centre under the aegis of Ahmedabad Chapter and Veraval-Porbandar Chapter for conducting interactive sessions for the Exam Aspirants of 1st and 2nd Class Mine Managers Certificate of Competency. This is an exceptionally welcome initiative and would go a long way in helping the Exam Aspirants.

With a cherished objective to create awareness amongst the mining fraternity, industrial workforce about the key amendments brought-in through an OSH Code, the Rajasthan Chapter-Udaipur held a technical talk / virtual talk on ‘Occupational Safety, Health and Work Conditions Code, 2020 – A View Point’.

The Rajasthan Chapter- Jaipur and Department of Mines and Geology Rajasthan have jointly organized a one-day workshop on “Rajasthan State M-Sand Policy: A Way Ahead”. The MEAI in association with the NMDC Ltd., organized a Webinar on “Advanced Blasting Techniques – Using Digital Platforms”.

These events are a testimony of our efforts to serve the Mining fraternity better.

Last but not the least, I would like to urge the readers to take care against the Pandemic and support the vaccination programme.

With Best Wishes

Sanjay Kumar Pattnaik
President

Mining Engineers' Association of India

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Dr. P.V. Rao
Editor, MEJ

Prospectors & Developers Association of Canada (PDAC) is the leading voice of the mineral exploration and development community with a mission to promote a globally responsible, vibrant and sustainable mineral sector that encourages leading practices in technical, operational, environmental, safety and social performance. The annual PDAC Convention that attracted over 25,000 people from 135 countries in recent years is the world's premier international annual event for the minerals and mining industry.

The Mineral Exploration & Mining Convention, held on 8-11 March 2021, has been the leading convention for people, companies and organizations in, or connected with, mineral exploration. PDAC has wrapped up its first ever virtual convention, receiving positive feedback and industry accolades. It was successful in bringing together mining executives, geologists, government officials, investors, analysts, and students from around the globe. PDAC President Felix Lee stated that he was thrilled to showcase the industry in a new, virtual environment for the first time in PDAC's 89-year-history. All attendees had access to a customized platform where they could navigate through various exhibit halls, network with colleagues, and join sessions that were available on-demand shortly after airing. This new virtual format allowed attendees to continue networking by sending direct messages to other participants, engaging through text lounges, and watching educational sessions and newly added content for three months post-convention. Diversity and inclusion are key priorities for PDAC and featured throughout its programming at the annual PDAC Convention.

Attendees learn next and best practices that could be applied to their work right away.

This convention is the culmination of advocacy efforts undertaken by PDAC throughout the year on behalf of its 7,200 members and the mineral exploration and development industry. PDAC convention helps the industry stay connected, which is more important than ever before. It has always been unmatched in its ability to connect attendees to the broader international mining and exploration community and keep them informed of the latest industry news, trends, and developments through its extensive programming.

Highlights of PDAC 2021 included participation of PDAC President Felix Lee in the announcement of Canada's Critical Minerals List by Canada's Minister of Natural Resources; international Stage featured presentations from various global mining jurisdictions; and an in-depth look at the future of space mining and the mutually beneficial advantages of both space companies and mining sector co-operation.

Frank Holmes, Chief executive and Chief investment officer at US Global Investors that specializes in natural resources and emerging markets investing, shared his thoughts on fiscal policies, to gold, to green energy and on where he sees the markets heading this year. Goldcore (Green Battery Minerals Inc.) CEO Tom Yingling discussed how his company finds numerous mines, while building and operating them too. Their high-grade graphite is "greener" and coarser compared to present world producers' graphite. Jumana Saleheen, Chief economist at CRU, while speaking more on the future of commodity prices, anticipated the growth of the electric vehicle (EV) market exponentially in the next 20 years. Investing guru Rick Rule, President & CEO, Sprott US Holdings offered his predictions for standout precious metals in 2021.

The Programming consisted of several themes that included Capital markets program, Corporate presentation forum for investors, Cutting edge, Exploration insights, Indigenous program, International stage, Keynote program, Letter writing presentations for investors, Master class series, Mining for diversity, PDAC one on one meeting program, Short courses, Student & Early career program, Sustainability program, Technical program and Affiliated events.

Exploration Insights is a high-profile venue for speakers who wished to present topical subjects at the convention in a forum outside the themed Technical Sessions. Selected from a call for abstracts, Exploration Insights showcased technical, policy and academic presentations that offer insight into current and topical subjects. The abstract themes chosen for presentation vary from year to year.

The PDAC Convention Planning Committee, responsible for planning and execution of the Technical Program, begins the planning process 1.5 years in advance of every convention to ensure delivery of the relevant programming and selection of the high caliber speakers. Industry experts are invited to share timely insights during these dynamic series of presentations. Attendees learn next and best practices that could be applied to their work right away.

- Editor

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NEWS FROM THE MINING WORLD

➤ Researchers find new way to locate untapped rare earths deposits worldwide

Geologists and materials scientists at the University of Erlangen-Nuremberg discovered a new way of finding previously unknown deposits of rare earths, or rare earth metals, worldwide.

In a paper published in the journal *Geology*, the researchers explain that contrary to what their name might suggest, sources of rare earth elements or rare earth metals are distributed fairly equally all over the world. However, there are only very few sources that are economically viable and they propose using a new indicator to identify such deposits.

When inspecting rock samples from the Vergenoeg fluorite mine in South Africa, they discovered that fayalite crystals in the sediment of granite-like magma can contain large amounts of heavy rare earth elements. The mineral, which is reddish-brown to black in colour, is mainly mined for use as a gemstone and is also used for sandblasting. Fayalite can be found worldwide in igneous rock and abyssal rocks.

"Atom probe tomography maps confirm the incorporation of the HREEs into the fayalite crystal lattice, facilitated by lithium acting as a main charge balancer and by high REE contents in the highly fractionated felsic parental melt that is related to the Bushveld LIP [large igneous province]," the article reads. "The high HREE concentrations of fayalite in concert with its high modal abundance (>95 vol%) indicate that the fayalite cumulates are the main host for the HREE mineralization of the Vergenoeg deposit."

To reach this conclusion, the scientists used laser ablation–inductively coupled plasma–mass spectrometry analysis and noticed that cumulate fayalite in the Paleoproterozoic Vergenoeg F-Fe-REE deposit of the Bushveld LIP contains the highest heavy REE contents ever recorded for the mineral olivine, with HREE enrichment of as much as 6000× chondritic values.

"Since heavy rare earth elements are becoming increasingly scarce on the world market, the discovery of fayalite as a new potential source for locating new deposits of rare earths is extremely important for the economy," Reiner Klemd, one of the authors of the study, said in a media statement.

At present, most known and economically viable sources of rare earths are located in China, where more than 80% of them are refined. This has resulted in a near-monopoly situation, with the Asian giant dominating international trade, particularly in heavy rare earths.

Valentina Ruiz Leotaud, Mining.Com | March 14, 2021

➤ Only one bid received out of four coal mines put up for second attempt of auction: Coal Minister

Only one bid has been received out of four coal mines that were put up for second attempt of auction under the 11th round of Coal Mines (Special Provisions) Act (CMSP Act), Parliament was informed on Wednesday. The technical bid for the Kuraloi (A) North mine in Odisha was received from Vedanta Ltd and an Empowered Committee of Secretaries (ECoS) will take a final call on it, Coal and Mines Minister Pralhad Joshi told Lok Sabha in a written reply.

"Out of four coal mines put up for second attempt of auction under 11th Tranche of CMSP Act & 1st Tranche of MMDR (Mines and Minerals Development and Regulation) Act, only one mine namely Kuraloi (A) North mine in Odisha has received one technical bid from M/s Vedanta Limited" Joshi said.

The Minister said as per the provisions, in case there is only one technically qualified bidder, such bidder shall be the qualified bidder. "....the Initial Offer submitted by the Technically Qualified Bidder shall be considered as the Final Offer submitted by the Qualified Bidder and the matter will be referred to Empowered Committee of Secretaries (ECoS) for appropriate decision with respect to allocation of the Coal Mine," he said. In the event, the ECoS decides that the coal mine shall be allocated to the qualified bidder, it shall be declared as the preferred bidder. "However, in the event the ECoS decides that the Coal Mine shall not be allocated to the Qualified Bidder, the tender process for the Coal Mine shall stand annulled. Accordingly, the matter was referred to ECoS and a meeting of ECoS was held on March 4, 2021, Joshi said.

PTI | Mar 10, 2021

➤ Mines ministry issues framework for non-ferrous metal scrap recycling

The Centre has issued a framework for scrap recycling of non-ferrous metals, including aluminium and copper, in a bid to cut down the scrap imports.

The mines ministry is also of the view that one of the key challenges faced by the non-ferrous metals industry is its heavy dependence on import of metal scrap and stressed that a major share of the demand is served by imports owing to the underdeveloped metal scrap collection, segregation and processing infrastructure in the domestic market.

"Ministry of Mines will work towards creating a sustainable scrap recycling ecosystem...National non-ferrous metal scrap recycling framework, 2020 seeks to use life cycle management approach for better efficiency in mineral value chain process," the mines ministry said. The framework envisages bringing both product and processing stewardship to enhance non-ferrous metal recycling, it said. The demand for aluminum has increased at compound annual growth rate (CAGR) of 6.77 per cent. The production has also increased from 3.3 million tonnes (MT) in 2015 to approximately 5 MT in 2019 with a CAGR of 11.19 per cent. Considering the growing demand for aluminium in future, there will be heavy dependence on domestic production and imports. In light of the fact that aluminium is an energy intensive sector, the demand for fuel, i.e. coal, being the main energy source for aluminum extraction and processing, will also increase, it said. Such dependence on non-renewable resources is not in line with global sustainable development goals and will lead to high carbon footprints. "Also, meeting the growing demand by imports would lead to a trade imbalance. Thus, recycling becomes a good alternative as it requires 95 per cent less energy to recycle aluminium than to produce primary aluminium," the mines ministry said. Copper demand in India is expected to grow at 6-7 per cent due to increased thrust of Centre towards 'Make in India' and 'Smart City' programmes, development of industrial corridors, housing for all Indians by 2022, National Highway development project, rail project and defence production policy to encourage indigenous manufacture, according to the ministry.

In addition to this, there is plan for green energy corridor for transmission of renewable energy. The market for electric vehicles (EV) is also expected to witness growth in coming years. Copper is essential to EV technology and its supporting infrastructure, and the increase in the electric vehicles in the market will have a substantial impact on copper demand, it said. The projected demand for copper due to electric vehicles is expected to increase by 1.7 million tonnes by 2027. The per capita copper consumption in India is expected to increase from the current level of 0.6 kg to 1 kg by 2025. If India's per capita copper consumption moves towards the world's per capita copper consumption of 2.7 kg, the country's copper market has the potential for significant growth.

The import of copper has increased at CAGR 10.65 per cent in the last five years. "As India is currently a net importer of copper, certain percentage of growing demand of copper can be met domestically through recycling," it said.

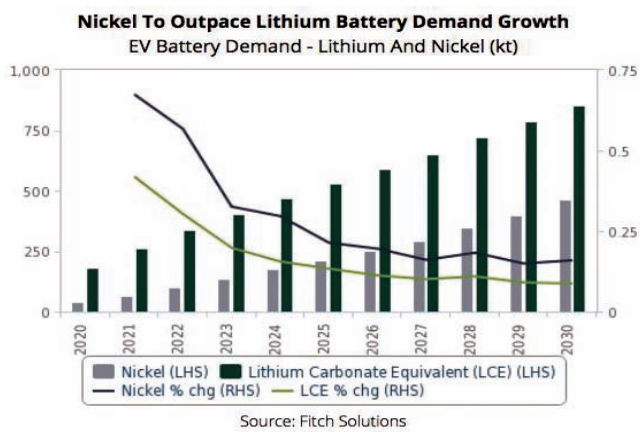
PTI | Mar 14, 2021

➤ Nickel demand for EVs to outpace lithium and cobalt – report

A nickel briquette. Image from Sherritt International

As battery metals continue to rise to the forefront of attention, much has centered around lithium and cobalt. Governments have enacted policies to encourage investment into the critical raw materials they deem essential to the green energy transition. At the same time, supply chain concerns surrounding nickel have begun to garner increasing focus.

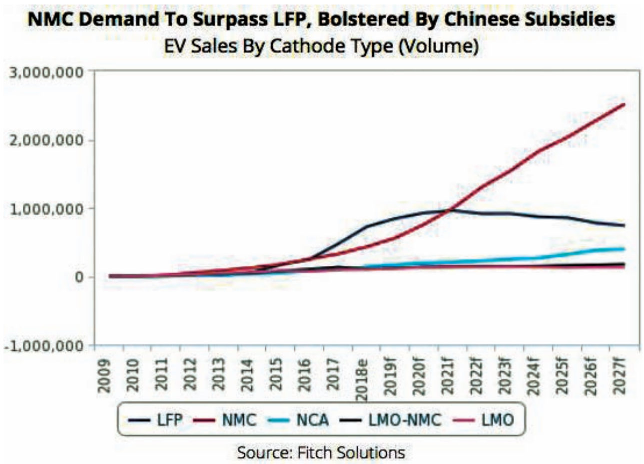
As a key component of battery cathode chemistry in many existing and upcoming electric vehicles (EVs), nickel will remain an important metal to watch in the coming decade, market analyst *Fitch Solutions* maintains in its latest industry report.



Fitch has updated its estimate of the impact of EV battery manufacturing on nickel consumption and now expects nickel demand for EV battery manufacturing to experience an annual average growth rate of 29% over 2021-2030, outpacing both lithium and cobalt demand, the analyst says.

Fitch estimates of the impact of EV battery manufacturing on nickel demand rely on its 2018 forecasts for demand by cathode type, isolating demand for the lithium-nickel-manganese-cobalt oxide (NMC) chemistry, which it expects to be the preferred cathode of choice moving forward.

The analyst also maintains the underlying assumption that NMC 811 cathodes will rise to 80.0% of NMC market share by 2027, which will effectively raise the average nickel content from 34.6kg to 44.5kg for each NMC cathode produced.



Automakers such as BMW, Hyundai and Renault use the NMC chemistry in their vehicles, and Tesla currently employs a lithium-nickel-cobalt-aluminum oxide (NCA) chemistry in its models. Going forward, *Fitch* forecasts, Tesla will exchange its NCA chemistry for three different offerings based on vehicle cost and performance: lithium-iron-phosphate (LFP), NMC and a high-nickel, cobalt-free option.

Nickel demand will be supported by the metals persisting popularity in battery cathode chemistry, with downside risks caused by concerns over future supply availability, *Fitch* notes and expects nickel-dominant cathodes to be favoured for automakers' heavy-duty and long-range vehicles.

However, *Fitch* says, a shortage of Class 1, battery-grade nickel may encourage automakers to explore lithium-iron-phosphate (LFP) batteries for mass-market vehicles.

MINING.com Editor | *March 16, 2021*

➤ What countries will fight over when green energy dominates

The Rand Corporation's been designing war games with the Pentagon since the 1950s, modelling such hard-nosed security scenarios as a two-front US war with China and Russia. Now the think tank is turning its realpolitik tool kit to a question more often associated with environmental dreamers: How will clean energy change the world?

Image by mohamed Hassan from Pixabay

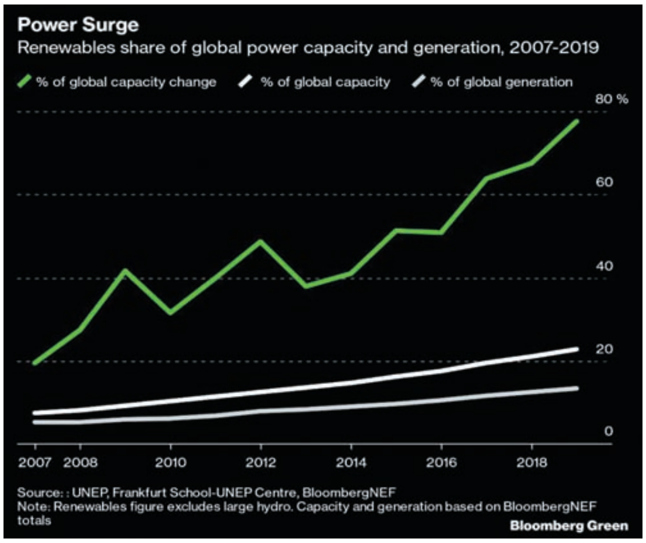
Rand is among the small but growing number of research organizations, universities and at least one European government that have started gaming out the gritty geopolitical implications of a globe dominated by green energy. It's the latest sign that the once quaint idea of renewable energy displacing fossil fuels has gone mainstream.

Last year was a turning point. China, the world's biggest polluter, finally joined the cascade of nations and companies setting target dates for carbon neutrality. The European Union for the first time generated more electricity from carbon-free sources than polluting ones. Joe Biden won the US presidency, bringing an ambitious climate agenda to the White House.

Addressing the United Nations Security Council last month, UK Prime Minister Boris Johnson ridiculed those who still think of climate change as "green stuff from a bunch of tree-hugging tofu munchers," unsuited to serious diplomacy.

Some experts even predict that the end of an era defined by uneven access to fossil fuel deposits will produce a security dividend, similar to the one that followed the end of the Cold War. After all, a latter-day Saddam Hussein would have little reason to invade Kuwait to seize its solar parks, as he did in 1990 for its oil wells, because there would no longer be anything special about Kuwait's patch of desert. It would be cheaper to buy panels to put on his own.

"Anyone can now become an energy player, that is the nature of renewable energy," says former Iceland President Olafur Ragnar Grimsson, who chaired an international commission on the geopolitics of the energy transition. Grimsson has already seen the green future. Iceland's energy mix is 85% renewable, and all its electricity is generated from clean sources. The last time his island nation saw conflict with another country over resources, it was about fish.

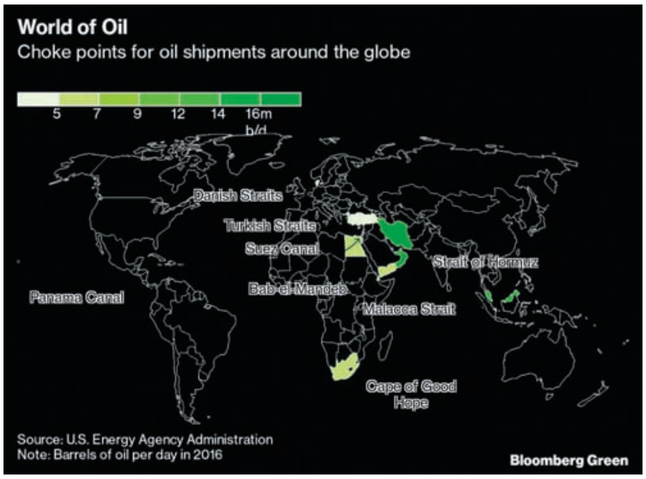


"You need a new geopolitical model, you cannot simply put renewables into the old coal and oil model," Grimsson says.

Until renewable dominance is reached, though, oil could have a long and destructive tail. For about three centuries, access to fossil fuels has shaped the rise and fall of great powers. Plentiful, well-located coal mines helped fire Britain's industrial revolution and the expansion of its empire. Oil and gas fueled the former Soviet Union's military power and shaped "the American century," including US alliances and fleet deployments.

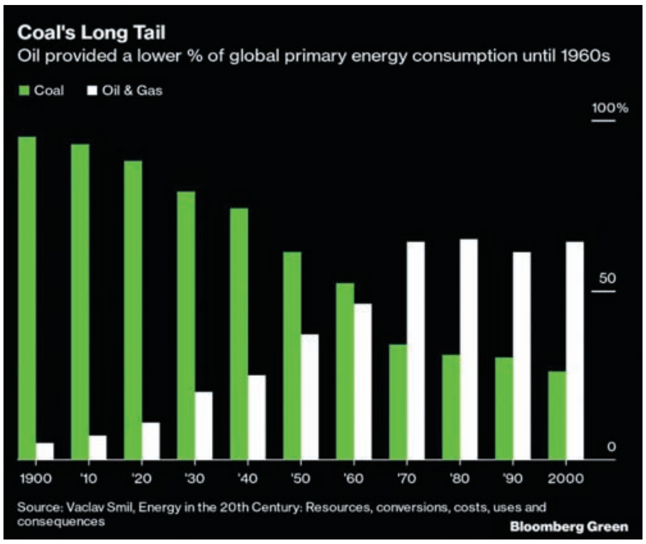
"We're not even close to a world dominated by renewables," says Andreas Goldthau, who heads a project at German's University of Erfurt that seeks to figure out the systemic impacts of the shift to clean energy.

Changing such a fundamental driver of the global pecking order could have multiple consequences. Vladimir Putin might struggle to sustain Russia's rise as an "energy superpower." An implosion of the US shale industry, combined with China's dominance in renewables manufacturing, could define the 21st century's great superpower contest. The rationale for American alliances and military bases in the Middle East would weaken. A sudden loss of oil revenues could trigger Arab Spring-style revolts against the most brittle petrostate autocracies.



The one thing we know about transitions, Goldthau says, is that "they are never, never linear." Think of the post-Cold War Yugoslav conflicts, or the shift away from planned economies that the former communist bloc began in the late 1980s. Many ex-republics, from Ukraine to Turkmenistan, remain in turmoil or stalled well short of market democracy 30 years later.

Nor do transitions necessarily end with a neatly tied bow. The Canadian scientist Vaclav Smil has mapped out coal's fall from 95% of primary energy use in 1900, to just 26% a century later. Yet in absolute terms, global consumption rose from an estimated 800-million tons a year in 1900 to about 5.5-billion tons today. Though the same might not happen to oil, the fuel is likely to burn much longer than most climate scientists would prefer.



It's hard to see a smooth, rapid energy transition taking place in the current competitive and nationalistic environment, says Eirik Waerness, chief economist of Norway's state-owned energy giant Equinor ASA. He took part in Grimsson's commission, and generally agrees with its optimistic conclusions. "For the energy transition to happen fully, we probably need a relatively benign geopolitical climate," Waerness says. "There is to some extent a virtuous circle we have to create here."

While the sources of clean energy are available to everyone, the battle will be over who profits from the products used to harness them. Solar panels, wind turbines and batteries will be in such demand that countries are already jostling to make sure they get their share of the pie. Many will get left behind.

About 60% of solar panels are manufactured by Chinese companies, a level of market influence the Organization of Petroleum Exporting Countries can only dream of when it comes to oil. That creates a big trade advantage, but not one President Xi Jinping can easily leverage for geopolitical ends.

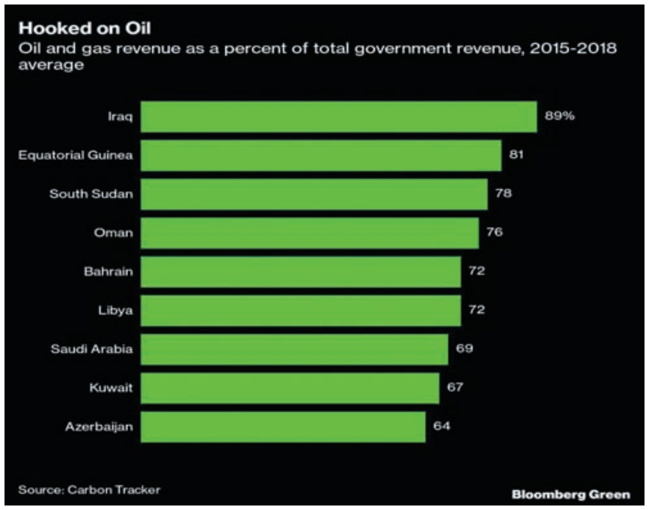
"What are you worried about? You buy it, you run it and once you have what you have they can't take it away from you," says Karen Smith Stegen, a professor of political science at Jacobs University in Bremen, Germany, who has examined the potential of 165 countries to emerge from the transition as political winners and losers.

Global inequalities and rivalries will instead likely center on access to technology and finance, standard setting and control of key raw materials. China controls more than 90% of some of the rare earth metals needed for electric vehicles and offshore wind turbines. It already used that monopoly power once, cutting off Japan's supply after a 2010 clash near islands both nations claim to own. Japan has since reduced the share of its rare earth imports that come from China by more than a third to reduce its exposure.

In November, Johnson's UK will host the COP26 climate summit in Glasgow, Scotland, where countries will negotiate the rules for the road ahead. Leaders want to make sure everyone else is doing their fair share to cut emissions, and that their countries don't lose out.

That fear could lead to what German economist Hans-Werner Sinn has called the "green paradox." He argues the transition could prompt oil producers—especially those with high extraction costs or shallow reserves—to start pumping as fast as they can while demand lasts. The increased supply would boost carbon emissions and also lower the price of crude, making it more competitive with renewables and slowing the move to cleaner energy.

Cheap oil could also decimate the budgets of fragile regimes before they have time to find other sources of revenue. A February study by UK think tank Carbon Tracker found that 40 fossil-fuel dependent governments would suffer an average 51% drop in oil and gas revenues if global climate targets are met. That could destabilize governments and leave the likes of Nigeria or Iraq unable to afford security to deal with threats from terrorist organizations such as Boko Haram and Islamic State.



A report last month by the European Council on Foreign Relations concluded that rich countries will have to help plug the financial holes. The EU's Green Deal, in particular, it said could have as great an effect on regional geopolitics as on the Earth's climate. The bloc produces less than 10% of global CO_2 emissions, but neighbors such as Algeria, Azerbaijan, Russia and Turkey depend on its market to buy a large share of their exports. Many of these are carbon intensive and vulnerable to the EU's planned carbon border tax.

And there's no guarantee that making nations more energy self-sufficient will reduce conflict. Oil is the most actively traded commodity on the planet, and any steep decline in demand would reduce those interactions. "What we know is trade is a good thing," says Goldthau at the University of Erfurt. "When states are interdependent they have a lower appetite for conflict."

Back at Rand, senior policy researcher Benjamin Preston has divided the world into three categories.

The first consists of countries such as Iceland, which already made the transition and have little more at stake. The second are the export-dependent petrostates that have most to lose.

The third and least-studied cohort is the array of countries in between that are both producers and consumers of fossil fuels. The temptation for these hybrid cases will be to decarbonize their own economies, while maximizing revenue from exports of oil, gas and coal, Preston says. That's a wild card with potential to impact both international politics and the duration of the transition.

Take China, which has installed more solar capacity than the rest of the world combined, but is also exporting even more coal-fired generation capacity. In one case, it literally dismantled an aging plant in Hunan province to reconstruct in Cambodia. Australia, another solar success story, recently opened a new coal mine to supply India, and greenlit the development of another $1-billion facility aimed at the Asian market.

The US, meanwhile, is hardly shutting down the fracking industry that for more than a decade has boosted its economy. Meghan O'Sullivan, director of Harvard's geopolitics of energy initiative, has argued that shale also gives the US significant foreign policy freedom. The added supply reduced potential for blowback from oil-price effects when America levied sanctions against Iran, blocking its oil from the global market.

As renewables expand, jobs and revenues in the US and other hybrid nations will become increasingly dependent on decisions that other countries make about whether to go on importing their fossil fuels, according to Rand's Preston. That's unlikely to fast-track a more peaceful renewable future. The trick, he says, will be to "enable safe landings for all the countries that have this kind of dependency on existing fossil fuels, but without shutting down the transition altogether."

Bloomberg News | *March 16, 2021*

➤ Researchers find new way to locate untapped rare earths deposits worldwide

Geologists and materials scientists at the University of Erlangen-Nuremberg discovered a new way of finding previously unknown deposits of rare earths, or rare earth metals, worldwide.

In a paper published in the journal *Geology*, the researchers explain that contrary to what their name might suggest, sources of rare earth elements or rare earth metals are distributed fairly equally all over the world. However, there are only very few sources that are economically viable and they propose using a new indicator to identify such deposits.

Fayalite crystal group from the Eifel region, Germany. *(Image by Fred Kruijen, Wikimedia Commons*).

Valentina Ruiz Leotaud | *March 14, 2021*

➤ Green hydrogen key to decarbonising mining – report

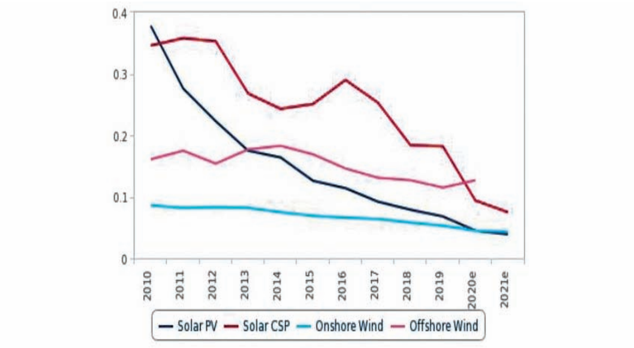
An example of a mine haul truck that will be converted to run on hydrogen. Credit: Anglo American Plc.

As decarbonisation targets drive emissions regulations, green hydrogen has significant potential to play an important role in decarbonising the mining sector in the coming years, market analyst *Fitch Solutions* says in its latest industry report.

Within the mining sector, *Fitch* expects transportation and energy storage to be the primary use applications of green hydrogen, with firms initially producing their own green hydrogen by investing in related on-site infrastructure.

Green hydrogen refers to the sourcing of hydrogen from renewable energy sources through electrolysis to split water. At present, green hydrogen accounts for only 0.1% of the global hydrogen market as its immense electricity requirements made production exceptionally expensive.

Falling renewables costs increase feasibility of green hydrogen mining adoption



Note: Auction prices have been corrected for inflation. e = estimates based on current auction values. Source: IRENA, Fitch Solutions

According to *Fitch's* Power & Renewables team, electricity costs account for roughly 50-75% of total green hydrogen production costs; however, *Fitch* says the downward trend in renewables electricity costs will benefit the industry's future growth.

Fitch asserts the use of green hydrogen will be one of the key factors to help decarbonise the mining and metals sector, via its transport and industrial production applications. Growing use of green hydrogen will prove beneficial to the mining and metals sector, increasing respective players' social licenses to operate within their communities as well as increasing financing options by meeting rising ESG standards, *Fitch* maintains.

Within the mining sector, Fitch expects transportation and energy storage to be the primary use applications of green hydrogen. Green hydrogen will be increasingly utilised to adapt mining haulage fleets, with Anglo American serving as a prominent first mover in the industry, *Fitch* says.

Anglo American announced in October 2019 a joint partnership with ENGIE to co-create the first green-hydrogen-powered mining truck. In November 2020, the firms reported that the electrolyser for the project had been delivered to the site by Nel Hydrogen Electrolyser AS, with the vehicle expected to debut in H1 20 21 at its Mogalakwena mine in South Africa.

Glencore has used a hydrogen energy storage unit and wind turbine to power its Raglan mine in Canada since 2015. Rio Tinto signed a Memorandum of Understanding (MOU) with Paul Wurth SA and SHS-Stahl- Holding-Saar GmbH & Co. KGaA to explore the transformation of iron ore pellets into low-carbon, hot briquetted iron using green hydrogen, and Fortescue entered a partnership with South Korean steelmaker POSCO to produce green hydrogen in December 2020, *Fitch* reports.

MINING.com Editor | *March 11, 2021*

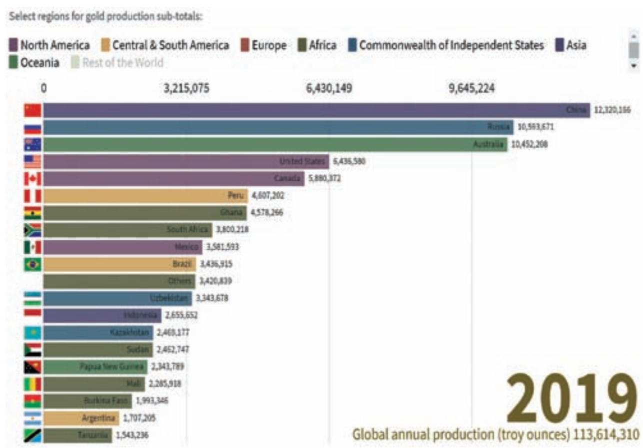
➤ Top 20 gold producing countries

World output of gold in 2019 showed the first decline in a decade, falling by 28 metric tonnes to 3,533 tonnes or 113.6 million troy ounces. The decline came after relentless growth in primary gold production – 730 tonnes or 23.5m ounces since 2010, according to London-based mining and metals consultants Metals Focus and the World Gold Council.

China is in danger of losing its no 1 ranking over the next few years – the country lost 20 tonnes of production while Russia added 34 tonnes or 1.1m ounces in a single year, shrinking the gap to 53.7 tonnes. A number of large new mines, like Sukhoi Log in the country's east, are in development to take the country to the top spot.

Russia overtook Australia in 2019 to take the number two spot, but the country also has an ambitious pipeline of new projects and like Russia, covid-19 did not impact production or project development significantly in 2020.

TOP 20 GOLD PRODUCING COUNTRIES



South Africa ranked number one in the world for a century before losing the top spot to China in 2007.

At its peak in the late 1960s, the gold fields of South Africa produced more than a 1,000 tonnes, double the output of the rest of the world combined. Last year the country's output fell to 130 tonnes, giving up its crown as top producer on the continent to Ghana

Frik Els, Mining.Com | *March 16, 2021*

GREEN MINING AND GEOSCIENCES FOR SUSTAINABLE GROWTH OF MINERAL WEALTH IN INDIA

Dr Sudesh Kumar Wadhawan*

Abstract

Mining has become increasingly difficult for societal and environmental reasons all over the world. The green mining programme involves a composite package of mineral exploration, sustainable zero-waste mining and mine closure plans for successive land uses for restoration of environment. Mining industry faces major challenges to improve its performance and image. It is a paradox that while people are not ready to radically reduce the use of mineral-based products, they vehemently oppose mining for various reasons. As water and energy are scarce in many important mining regions, there has been an increasing competition with other types of land uses. Ministry of Mines has facilitated and incentivised free flow of base-line geosciences data for all stake-holders for sustainable development of mineral and mining sectors in India. This concept paper elucidates the various aspects of green mining practices as linked to modern integrated mineral exploration techniques, public good geosciences, resource conservation and emerging challenges for sustainable growth of mineral wealth in India. It is imperative that such integrated approach requires cooperation and collaboration amongst the mining majors, geoscientists in Government organisations, private consultants, mine owners and R & D Centres at all relevant levels with networking to collect and disseminate its geoscientific database, adopt modern technology to improve productivity through sustainable green mining practices.

INTRODUCTION

As human societies are becoming increasingly more sophisticated - the consumption of mineral commodities has not only grown manifolds, but also diversified. There has been a growing demand and consumption of several metals, extracted from the ever enlarging mining and mineral processing activities (Figure-1; Sverdrup et al., 2013). Today's society recognizes that it requires not only resources from its surroundings – its environment – for development, but also rendering this development environment friendly in order to avoid loss of natural capital and degradation of environment. Furthermore, there is recognition of temporal relationship with natural resource identified through the concept of sustainable development wherein the ethical considerations suggest that man should utilize resources to meet not only today's needs, but also the needs of future generations. This would require addressing issues such as technical capability, ethics and rational approach for ultimate protection and preservation of environment for sustainable growth. Consequently, upgrading and maintaining levels of standards of living, today's society looks at the geoscience not only for providing for its water, mineral and energy requirements, but also generating data to resolve issues regarding impact of a variety of infrastructural and developmental projects, including mining on environment, prevalence of natural hazards, health hazards and ways for their mitigation.

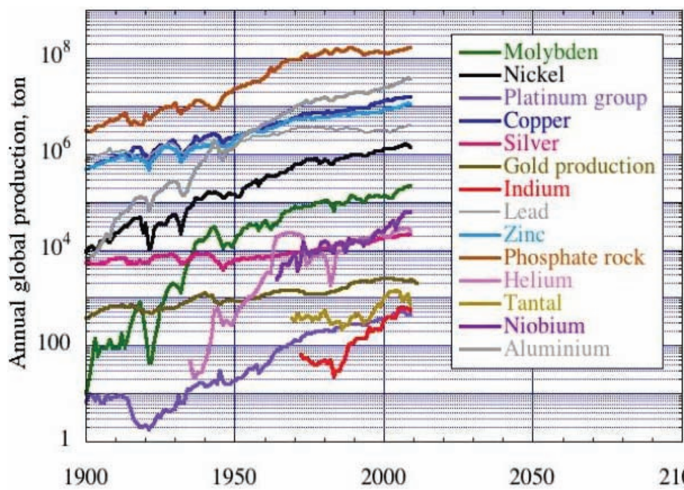


***Figure 1**: Output from global mining for selected metals and elements (after Sverdrup et al., 2013)*

The mining industry is growing in importance the world over. Such growth offers Indian mining companies an opportunity to become leaders and unlock their potential for developing sustainable mining ventures. Green mining represents an active effort to find improved working methods and operating practices. Green mining combines an industrial production process with ecological operating practices. The objective is to minimise adverse impacts of mining through compliance with environmentally and socially sustainable

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entire cycle of extraction and beneficiation processes and to ensure alternative land uses post mine closure. The two central themes of green mining programmes are: augmentation of new mineral resources and intelligent, minimum impact mining. Essential aim of the green mining programme is intended for both the mining sector as well as the technology industry and service providers coming together and supporting each other in sustainable ways that are promoting environmental conservation and restoration. Particularly the large mining companies, the PSUs and multi-nationals, are expected to set up network projects and research programmes to share their outcomes and encourage small and medium enterprises to develop their activities for optimising material, energy and water efficiencies through recycling and recovery of associated metals and minerals.

Recent policy initiatives by Government of India, Ministry of Mines (2016) have facilitated and incentivised free flow of base-line geosciences data for all stake-holders for attracting foreign direct investment, optimum utilisation and sustainable development of mineral and mining sector in India. This concept paper elucidates the various aspects of green mining technology as linked to modern geoscience concepts based mineral exploration techniques, public good geosciences, resource conservation and emerging challenges for sustainable development framework for growth of green mining sector.

GEOSCIENCES FOR SUSTAINABLE GROWTH OF MINERAL WEALTH

It is observed that National Geoscientific Survey organizations all over the world function as eyes, ears and cerebrum of the Government. The basic functions of a geo-survey organisation are: - continuous collection, synthesis and dissemination of geoscientific data. These are the mandated activities to be pursued relentlessly and objectively without compromising on the quality of data generation. This view had been deliberated even at the World Mines Ministers' forum at Toronto in 2002 and the consensus was that building up of fundamental geosciences database could not be left to ever changing market forces even during the regime of market economy (High Powered Committee Report, Ministry of Mines (Government of India, 2009). It was further emphasized that Geological Surveys should continue to generate geoscientific data for long-term understanding of the earth system and operative processes. Therefore, the real value of basic earth science data cannot be reflected in the annual balance sheets and profits and loss accounts as commonly understood by financial wizards.

Geological Survey of India (GSI), the second oldest National Survey Organisation of India is no exception to this concept. The priorities before such an organisation are in conformity with the priorities before the nation as a whole. In view of the strides made in recent years in technology and its application the world over, new knowledge-skills and understanding the earth process, along with concurrent advancement in information, communication and satellite technologies, new vistas have been opened in the field of earth science related studies. Considering the global trend and national priorities, the challenges before the national geoscientific organisation, GSI, which was restructured in 2011, and the State Departments of Geology and Mines and Geoscience R&D Departments can be outlined as follows: -

i) Constantly gather, update and refine basic geosciences data for better understanding the earth system and processes.

ii) To be front runner in national building process through augmentation of existing mineral, water and energy resources.

iii) To evolve for the task of maintaining sustainable growth through prioritizing Public Good Geoscience Services.

iv) Geo-information Management through establishment of sound mechanism towards archival, processing and dissemination or sharing of data through customized applications.

GSI will also provide information to the Central Government on potential basic geoscience prospected/ explored blocks ready for the purpose of auctioning and notification for mining leases. Ministry of Mines' National Mineral Exploration Policy 2016 [for non-fuel and non-coal minerals] further elaborates the role of Indian Bureau of Mines (IBM) to be the principal agency for carrying out the mineral beneficiation studies with focus on: -

1) Identification of lean ores or waste of important technology metals and development of beneficiation techniques in collaboration with other laboratories and institutions;

2) Energy efficiency studies in mineral processing;

3) Water conservation and development of water recycling circuits in processing and

4) Upgradation of existing processes and mining practices to make them more environmentally friendly

However, environmental concerns need to be addressed seriously while applying modern integrated techniques in mineral exploration, right from inception stage itself and onwards. Leaving aside the 'no-go' or the 'inviolate' areas environmental clearances for the invasive mineral exploration activities such as collection of rocks and stream samples, pitting, trenching drilling and exploratory mining, a suitable legislation must facilitate and provide for promoting environmentally safe mineral exploration activities for creation of national geoscientific database for resource assessment of the area.

PUBLIC GOOD GEOSCIENCE SERVICES AND SUSTAINABLE DEVELOPMENT FRAMEWORK (SDF)

Geoscience and sustainable development study involve understanding of two major set of conditions:

(i) Physical conditions and

(ii) Social and cultural conditions.

Physical conditions constitute mostly the abiotic attributes of the environment such as the earth material, minerals, soils, water, landforms, air that together affect growth and development of man. The social and cultural conditions include environmental parameters such as the ethics, economics, aesthetics, etc. which affect the behaviour of individuals or a community.

The present global trend before worldwide geological surveys and mining sectors is to foster harmony between **'wealth creation'** and preservation of **'ecology and environment'**. The domain of earth's resources extends beyond the utilitarian extraction of exhaustible minerals from the earth, and impinges on every aspect of development (Bruntland, 1987; Carter, 2011). Understanding the dynamic phenomena and geologic processes on the surface is becoming more and more an area of focal concern in sustainable development as the incidence of geological hazards and the geological backlash of ill-informed anthropogenic action affect society.

It involves geoscientific baseline data generation, particularly in relation to dynamic geologic phenomena such as the fluvial systems, landscapes, soils, sea coast and fragile ecosystems (Diwedi, 1999). Natural hazards are mostly the consequence of geological processes. Planning for smart urban and rural settlements, infrastructural development for mining, multidimensional construction activity, landslides and erosion, floods and silting, earthquakes, waste disposal (both solid waste and other types of hazardous and nuclear waste) and water supply are all such activities in which geofactors and geotechnical attributes need to be considered from the planning and execution stages. These are the areas in which Geoscience departments will have to evolve to face the daunting task and accord priority to or adopt the following strategy: -

- Provide geoscientific data input and expertise for management of natural and manmade environmental hazards
- Optimize development in civil projects, energy sector, and communication
- Mitigate risks due to natural hazards/catastrophe for the safety of the society
- Define and delineate areas prone to environmental degradation
- Effectively contribute towards climate change vis-à-vis global warming related studies which threatens the very existence of this planet

Sustainable Development Framework of Ministry of Mines (Government of India, 2011) for mining sector also endorses that India needs to ensure environmental sustainability and zero waste mining. In order to ensure resource use efficiency, it is necessary that the entire deposit is properly delineated and economically extracted through a technically sound mining plan (MP). A carefully designed MP will maximise mineral extraction, including beneficiation of low-grade ores and minimise environmental damage. It is therefore, imperative to develop capacity with the required skills to approve and then enforce implementation of such Mining Plans. MP also needs to ensure that commercial extraction of all secondary or associated minor minerals/ metals which often occur in low concentrations are extracted or separated by metallurgical methods developed through dedicated R&D efforts. Many strategically important metals or energy critical elements do occur associated with some major minerals and sulphides, such as Molybdenum and Selenium from Copper ore; Cadmium and Germanium from Zinc ore and Gallium and Vanadium from Bauxite, the Aluminium ore, etc.

Another important and essential aspect of SDF is preparation of scientifically appropriate and technically feasible Mine Closure Plan based on and intricately linked to the activity plan of different stages of mining. Adoption of scientific exploration and technically sound mining practices will support a systematic mine closure plan that needs to be aligned with the EMP developed to meet requirements of the Environment Protection Act 1986. It is pertinent to ensure that the mine once exhausted or at the end of its useful life is progressively and economically closed and prepared to be made ready for alternative land uses.

GREEN MINING TECHNOLOGY AND GEOETHICS

The mining industry needs long-term planning, requires adequate capital and includes high risks. Successful mineral exploration is the basis for sustainable mining. However, mineral exploration needs high-risk investment in projects that only seldom lead to economic discoveries or addition to existing reserves. The time needed to bring a new deposit into production from the start of the exploration project can easily be 10 to 15 years. Commodity prices are highly volatile, and during the operation time of a major mine there are many ups and downs in mineral market.

The Green Mining concept was developed in 2011 as a major forerunner tool in the sustainable mining (Nurmi and Wiklund, 2012; Nurmi, 2017). This concept is based on following five pillars: -

1. Promoting materials and energy efficiency. Methods that save energy and materials in mining and the enrichment of minerals have to be developed. The purpose of these new solutions is to allow the recovery of all useful minerals and by-products, and to minimise the amount of waste. The lifespan of many mineral-based products is long and commodities are recyclable in most applications. Therefore, once produced, metals and minerals remain available for future generations, and sustainable societies will create effective mechanisms for conservation and recycling thus reducing the growing need for primary resources.

2. Ensuring the availability of mineral resources for the future. Mineral raw materials are unevenly distributed across the Earth and concentrated in small volumes of the crust through distinct geological processes. Mineral deposits as such are non-renewable and ore reserves at existing metal mines are finite. Green Mining aims to ensure the availability of mineral resources for the future. Besides resource conservation and recycling, this would necessarily entail larger investment in modern mineral exploration and comprehensive resource reserves assessment vis-à-vis the supply and demand aspects of mineral economics specific to any country.

3. Minimising adverse environmental and social impacts. The goal of Green Mining is to minimise the adverse environmental and social impacts in all stages of the mining and mineral processing operations. Processes for establishing the pristine reference environmental conditions will aid in maximising the societal, economic and cultural impacts in a sustainable way. Participation of the affected community through their role in utilising the District Mineral Fund will go a long way for a balanced growth of mineral wealth and well-being of the society. The central theme is that all stakeholders must benefit from mining and regional development.

4. Improving work and organisational practises. Safety and security of mine workers is paramount. Mining takes place in remote and harsh conditions, employing heavy machinery and a variety of chemicals and explosives, which always involves potential safety hazards. Good working culture, occupational safety aiming at zero accidents are important starting points in all such development. Automation and application of remote and digitally controlled mining methods and enrichment plants need to be evolved as cost-effective to implement better safety standards and practices.

5. Ensuring sustainable land use following mine closure. Closure of a mine also requires functional and tested technical and scientific methods, so that the quarries, waste areas and other infrastructure can be restored in a way that allows further sustainable use of the area according to the approved plans. The costs of reclamation must be factored into the commodity cost, and funds to accomplish reclamation must be set-aside. A broad-based participation of local residents and other stakeholders will ensure timely conflict resolution, acceptability and benefit the society.

The green mining programme involves a composite package of mineral exploration, sustainable zero-waste mining and mine closure plans for successive land uses for restoration of environment (Figure-2). Application of advanced technology can further enable discovery of new mineral deposits buried deep underground. It develops new, environmentally friendlier exploration technologies. Similarly, by developing enrichment technologies whereby even deposits containing lesser quantities of valuable metals can be profitably exploited are promoting concept of green mining. Modern metallurgical technology can result in multi-metal extraction for some valuable by-products of energy critical and strategic metals in cost effective ways (PDAC, 2014).

***Figure-2**: Mine closure plans for successive land uses and for greening and restoration of environment*

Governments the world over are increasingly concerned about the environmental impact of the mining industry and impose severe environmental constraints on mining activities. As a result, for instance, Canadian copper mining companies moved to Chile. Environmentally sustainable mining is expensive whereas mineral prices are still low. Mining of high-grade ores can be profitable and that too when operated on very large scales. To find such sites and resources for future generations, great expertise in exploration and thus geological skills are required (Lambert and McFadden, 2013; Wadhawan, 2017; 2020). The same applies to relatively cheap aggregates and construction materials as well. In densely populated countries such as the Netherlands, combined extraction pits for both clay and coarse sand are becoming increasingly common; consequently, the landscape is less degraded. To assess the geochemical impact of mining and the environmental impact of its tailings, geoscientists need to assess the vulnerability and risk factors and suggest suitable remediation. They may contribute to the development of adequate chemical, physical or biological ex-situ and in-situ remediation methods for polluted or unstable tailings. In addition, geoscientists can play a key role when it comes to environmental monitoring, because they are familiar with the geochemistry of mining. Therefore, as a reference, it is essential to measure the original background values of the soil and water geochemistry during the exploration stage itself. Since these are closely connected with the natural geological conditions of rocks soils and geohydrology, establishing a reliable database and framework of reference is imperative.

The adoption of ethical principles is essential if geoscientists want to best serve the public good. Ethical responsibility by all geoscientists requires a more active role while interacting with society. Geoethics, which investigate the ethical, social, and cultural implications of geosciences research, practice, and education, represents a new way of thinking about and practicing earth sciences, focusing on issues related to the relationship of the geoscientist with the self, colleagues, and society in the broadest sense. Geoethics consists of research and reflection on those values upon which one bases appropriate behaviour and practices in situations where human activities intersect the Geosphere. Geoethics deals with the ethical, social and cultural implications of using Earth sciences for societal benefits. It is thus a meeting point of Geology, Sociology and Philosophy (Peppoloni & Di Capua, 2012).

The outcome document of Rio+20 (2012), entitled "The Future We Want", recognizes (points 39 and 40) the necessity to "promote harmony with nature" and "to lead to efforts to restore the health and integrity of the Earth's ecosystems". Therefore, the knowledge of the Earth systems science (geosphere, atmosphere, hydrosphere, cryosphere and biosphere), their processes and interactions should be an essential basis for an appropriate management towards sustainability.

It is both recognised and documented that a prerequisite of sustainable development must be to ensure uncontaminated streams, lakes and oceans. There is growing public concern about the condition of fresh water in the world including India. Unplanned mining may affect fresh water through heavy use of water in processing ore and through water pollution from discharged mine effluent and seepage from tailings and waste rock impoundments. Water is essential to life on the planet. Many non-governmental agencies now cite that water is the "mining's most common casualty." While the mining practices in recent years have been showing an increasing trend towards mechanization and risk mitigation, significant environmental water related risks remain. Besides, in the absence of adequate prevention and control strategies, erosion of the exposed earth may carry substantial amounts of sediment into streams, rivers and lakes. Excessive sediment load can clog riverbeds and damage watershed vegetation, wildlife habitat and aquatic organisms. Remediation to such issues calls for scientific long-term planning as part of green mining strategy.

DISCUSSION AND CONCLUSION

In view of Government of India's growing focus on development of rural economy and infrastructure which has been getting a generous allocation of funds in successive annual Budgets, it would certainly act as a catalyst for meeting growing demand for metals and minerals. Mining must be committed to the principles of harmonious and sustainable development; protecting human life, health and environment and adding sustainable value to the societies and communities.

With near exhaustion of shallow mineral deposits, new mineral exploration techniques are needed to find remote or deeply buried deposits. Huge investments through private-public cooperation are needed to develop these techniques. Mining industry is developing technology to maximize efficiency, minimize waste and reduce the consumption of water. As it supports economic growth, not only of the resources sector, but also of the service providers and manufacturing sectors supplying the industry, it needs to be encouraged through incentives and tax exemptions. Modern technology can also offer the potential for opening up previously inaccessible resources.

Responsible resource development should ultimately lead to alternative land uses, such as biodiversity protection, agriculture and urbanization. However, the consumption patterns by society needs to be in conformity with sustainable socio-economic growth. New scientific approaches, new interdisciplinary linkages, new demands arising out of socio-economic development and of course, new ecosystem situations, all will have major impact on the expectations and work outcomes of a national geoscientific organization. Therefore, it is incumbent that GSI must acquire and provide expertise and widely disseminate geoscientific information to facilitate informed decision making by policy makers and public and enable use of geoscientific and geospatial data for sustainable growth of the mineral wealth and environmental conservation (Wadhawan, 2011).

As a provider of expertise and disseminator of information to policy makers, commercial users and society, GSI performs a public service. All non-commercial data other than that restricted on considerations of national security must not only be made available in the public domain, but GSI must constantly ensure that the data is as complete and accurate as technology permits, and is easily accessible to society in a form that would be generally required for socio-economic purposes. To achieve this would require development of sophisticated geospatial and multidisciplinary applications on a continuing basis.

Nevertheless, as a facilitator, GSI sustaining on government funds, need not always and in every area be at the centre of such activity. It could be an 'incubator', as it has been in the past, developing new areas of expertise and promoting capacity building for and in collaboration with for the States and other R&D specialized organizations. Again, as a facilitator, it could be a catalytic 'clearing house', a one-stop reference centre for geoscientific data, no matter where the activity centre may be located.

Capital intensive mining industry needs to adopt modern technology that is energy efficient and less polluting and would necessitate creation of responsible and highly skilled workforce. It would also have a strong focus on health, safety and environment thereby enhancing the lives of the local communities. The main objective of green mining is to minimise adverse impacts of mining through compliance with environmentally and socially sustainable entire cycle of extraction and beneficiation processes and to ensure alternative land uses post mine closure. Green mining technology combines an industrial production process with ecological operating practices. Essential aim of the green mining programme is intended for both the mining sector as well as the technology industry and service providers coming together and supporting each other in ethical and sustainable ways that promote environmental conservation and restoration.

In order to facilitate integration of geosciences into policy making for environmental issues and to transmit the innovative concepts to potential interest groups, including policy makers, non-governmental environmental agencies and general public, it is further recommended that:

1) The large mining companies, the PSUs and multi-nationals, need to set up network projects and research programmes and to share their outcomes and encourage small and medium enterprises to develop their activities for optimising material, energy and water efficiencies through recycling and recovery of associated critical metals and minerals.
2) For developing strategies (including optimum land use) and a framework and methodology for promoting collaboration and coordination through best use of geoscientific data gathered in the course of survey and exploration by GSI and other geoscientific organizations in the country for sustainable development.
3) Various aspects of green mining technology as linked to modern mineral exploration techniques, public good geosciences, resource conservation, it is imperative that such integrated approach requires cooperation and collaboration amongst the mining majors, Government organisations and R& D Centres at all relevant levels with networking to collect and disseminate its geoscientific database, adopt modern technology to improve productivity through sustainable green mining practices.

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EXPLORATION AND MINING ON THE MOON FOR HELIUM-3 (^{3}HE) AND RARE EARTH ELEMENTS (REES)

P. V. Sukumaran

Abstract

Space exploration and mining are no longer a subject of science fiction; it could be a real possibility very soon and the prime target could be the moon. The moon is a potential source of ^{3}He gas that could fuel future nuclear fusion reactors on earth. 99.99 % of natural helium is ^{4}He, a stable isotope of the element, the rest being ^{3}He another stable isotope. There is very little ^{3}He available on the earth, but is a 100 million times more abundant on the lunar regolith. ^{3}He is emitted by the sun within its solar winds and reaches the lunar surface unhindered, accumulating there for billions of years. As the moon does not have an atmosphere and magnetic field, there is nothing to stop ^{3}He from arriving on its surface. This ^{3}He could potentially be extracted by heating the lunar dust to around 600° C, before bringing it back to the earth to fuel nuclear fusion power plants. With a tonne of ^{3}He valued at $3 billion it is hardly surprising that a serious interest is being taken in lunar ^{3}He.

Though there is no dearth of REE deposits – the cutting-edge modern technology elements, around the world, their mining, beneficiation, metallurgy and refining constitute a complex process. The temperatures of the near-side lunar hemisphere are higher than those on the far side because of the higher abundances of the heat producing elements U and Th. The early lunar surface was a magma ocean (Lunar Magma Ocean, LMO) differentiation of which left a residuum relatively enriched in incompatible elements. One component of lunar rocks, KREEP (enriched in K, REEs and P), represents the last chemical remnant of LMO. Such a residuum is hypothesised to exist as a KREEP reservoir associated with Th and U at depths under the Procellarum KREEP Terrane. The data show that the majority of radio-elements are restricted in PKT, suggesting that the Procellarum region is where KREEP rocks are concentrated, constituting the target for future REE mining.

Introduction

Space mining continues to be a subject of science fiction for now, but it could be a real possibility very soon and the prime target could be our very own moon. Commercial organizations are interested in the moon as a potential source of raw materials, the most valuable of which may be the Helium-3 (^{3}He) gas that could fuel future nuclear reactors on earth. The supreme importance of Rare Earth Elements (REEs) in today's cutting-edge technology was highlighted in my previous articles on REEs. These high-tech metals have unique metallurgical, chemical, electrical and magnetic properties aptly suited to modern electronic industries that manufacture a variety of miniaturised and light-weight electronic consumer goods and gadgets. The Peoples Republic of China has been the forerunner in REE mining, refining and production of endless downstream electronic goods containing REEs and over the years has become masters in REE technology. Though there is no dearth of REE deposits around the world, their mining, beneficiation, metallurgy and refining constitute a complex process producing effluents laced with radioactivity, and toxic heavy metals. The industrialised world is reluctant to indulge in REE technology, particularly in upstream processes of mining, beneficiation and refining of these metals for obvious reasons. The present global REE situation (supply crunch and critical nature) is taking us back to the early 1970s, when these elements were identified on lunar rocks. Can the lunar rocks bridge the gap in demand and supply of these wonder metals here on earth? Can it reduce our dependence on earth-based supply of resources? Do the present space mining laws permit such a venture?

Only one side of the moon is visible from the earth. This occurs when a celestial body orbits too close to another. As moons get closer to a planet, the gravitational tidal effects from the planet induce synchronous rotation, wherein the moon spins on its axis only once each time it orbits the planet. Thus, the same side of the moon always faces the planet. Such tidal locking keeps one side of the moon facing earth at all times.

The dark patches on the moon are large, lava-filled, impact basins that were created by asteroid impacts about 4 b y years ago. Scientists have long known that the temperatures

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of the near-side hemisphere of the moon were higher than those on the far side: the abundances of the heat producing elements U and Th are higher on the near side than the far side, and as a consequence, the vast majority of volcanic eruptions occurred on the moon's near-side hemisphere. The dark, lava-filled basins, or lunar maria are named Oceanus Procellarum (Figs. 1-3) and Mare Imbrium.

REEs in Lunar Rocks

REEs were detected in lunar rocks ever since samples returned during the Apollo landing missions of late 1960s and early 1970s were examined in the laboratory. The Apollo lunar missions and the unmanned Soviet Luna Landers had brought lunar samples to earth, the former 382 kg of lunar materials from six different areas of the moon's surface. What was obvious in the early stages of lunar sample studies is that lunar rocks are petrologically not as varied as terrestrial rocks. Based on scientific study of these samples the lunar rocks were classified into three major groups: The pristine **highland rocks** (Fig.1), covering 80% of the lunar surface, are composed of ferroan-anorthosites, troclolites, norites, gabbro-norites and dunites, making up the lunar **highlands** (the light hued areas of the moon as seen from the earth); the pristine **basaltic rocks** (Fig.2), enriched in FeO and TiO_2 and depleted in Al_2O_3 forming lunar lowlands or **Maria** covering 16% of the lunar surface, which are huge impact basins (the darker-hued areas); and polymict clastic breccias produced by multiple impacts and are mixtures of different rock types. The lunar highlands predate the Maria in age by about 800 m y.

KREEP: Prior to 4.5 b y ago the lunar surface was a liquid magma ocean (Lunar Magma Ocean, LMO). Differentiation of LMO left a residuum relatively enriched in incompatible elements (those elements with larger ionic radii that go into the melt phase on melting). One component of lunar rocks, KREEP (enriched in K-potassium, REE-Rare Earth Elements and P-phosphorous), represents the last chemical remnant of LMO. Such a residuum is hypothesised to exist as a KREEP reservoir associated with Th and U at depths on the moon under the **Procellarum KREEP Terrane** (Fig.3.Right). (**Terrane** is a block of the earth's crust that differs from the surrounding material, and is separated from it by tectonic faults, while **terrain** is a single, distinctive rock formation; a landscape or an area having a preponderance of a particular rock or group of rocks or a set of landforms). KREEP is actually a composite of what are called "incompatible elements", elements that cannot fit into a crystal structure of minerals and thus were left behind, floating to accumulate at the surface of the magma.

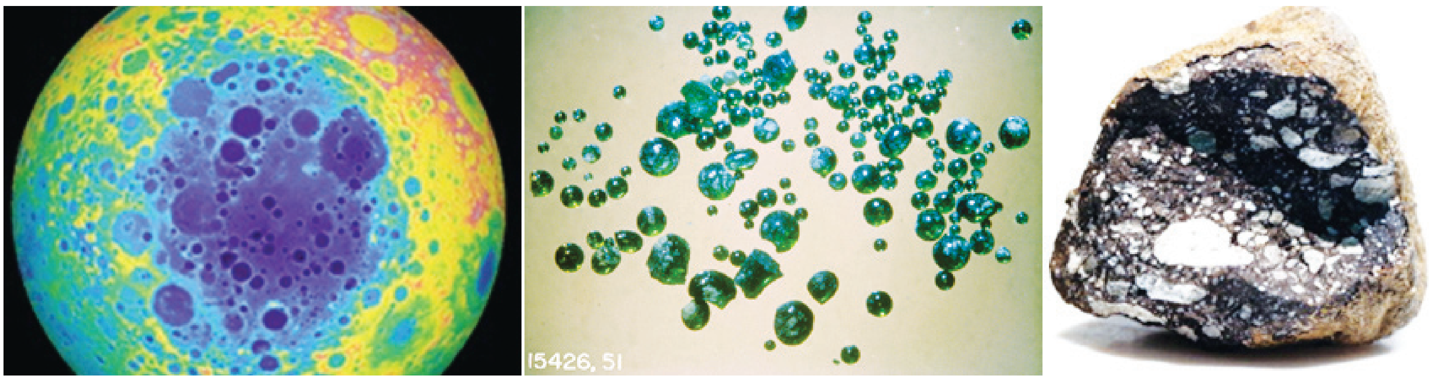

Fig.1.-(Left:) An elevation map of the Moon's South Pole- Aitken basin. Deep blue are the deepest areas (maria) while light rose represents highest area (highlands. (image: Wikipedia.org). Fig.1-(Middle): Volcanic glass beads from lunar regolith (image: NASA). Fig.1-(Right): The first recognized lunar meteorite Allan Hills (ALH) A 81005. It is a regolith breccia, the white inclusions are anorthositic rock fragments. Lunar regoliths are huge repositories of ^{3}He (image: Wikipedia.org)

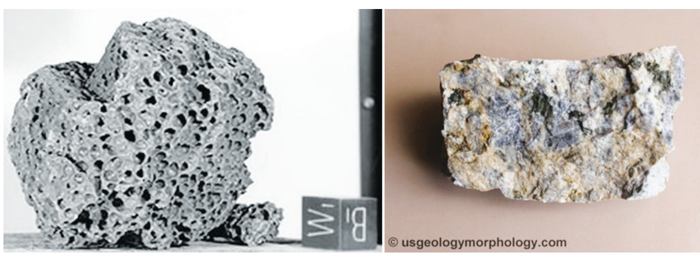

Fig.2. (Left) Lunar basalt, Apollo 15 (image: geokem.com), (Right) Highland anorthosite. The chief lunar minerals are plagioclase, pyroxene, olivine, silica, ilmenite, mare glass and highland glass (image:usgeologymorphology.com)

In order to better understand the Moon's overall chemical composition, Lunar Prospector Gamma Ray Spectrometer and the X-ray Fluorescence Spectrometer have studied the composition of the Moon's surface from lunar orbit. These experiments were flown on both *Apollo 15* and *Apollo 16.* Some elements, such as U and Th are naturally radioactive and emit gamma-ray (γ-ray) during radioactive decay. Besides, the bombardment of the lunar surface by Galactic Cosmic Rays (GCR) causes some other elements to emit gamma-rays. A Gamma Ray Spectrometer (GRS) can measure gamma rays emitted by radionuclides of elements and from γ-ray intensities so measured it is possible to extract elemental concentrations from the GRS data. The information so obtained of the lunar surface was converted into maps showing concentration of these radionuclides among the three major lunar crustal terranes, namely Procellarum KREEP Terranes (PKT) (Fig.3 R; Fig.4), Feldspathic Highlands Terranes (FHT), and South Pole Aitken Terranes (SPAT)).

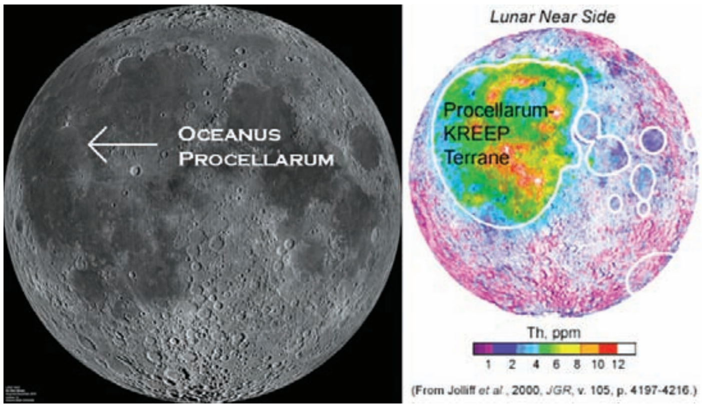

Fig.3 (L) Oceanus Procellarum, the dark shaded lava basin of the near side of the moon. (R) Procellarum KREEP Terrane of the moon (Near side), the target of future REE mining (From: Jolliff, B.L. et.al 2002).

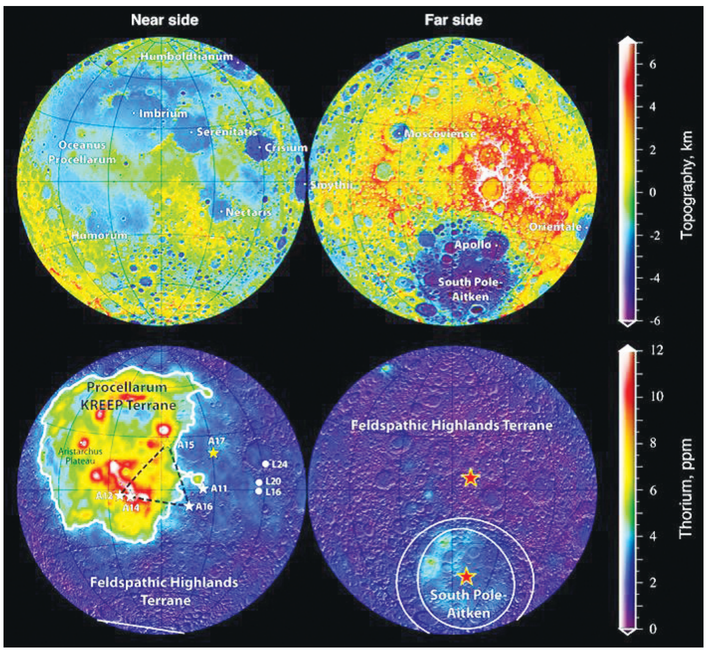

Fig.4. Topography of the Moon and surface abundance of Th. The thick white contour at 4 ppm Th delineates the approximate confines of the Procellarum KREEP Terrane, and the thin white ellipses on the far side outline the floor and structural rim of the Aitken basin near the South Pole. Stars and circles on the nearside represent the Apollo and Luna sample return stations, respectively. Yellow stars correspond to the locations where two heat-flow measurements were made, and the black dashed lines connect the four Apollo stations containing seismometers that operated in a network fashion. The two red stars on the far side hemisphere mark the proposed landing sites for Far-side Explorer. (image: Mimoun et al, 2011)

The data also show that the majority of radio-elements are restricted in PKT, suggesting that the Procellarum region is where KREEP rocks are concentrated. Therefore, it is the Procellarum KREEP Terrane that will be target for future REE mining. The GRS measured this radiation from lunar orbit to produce maps of the abundances of Th, Fe, and Ti on the lunar surface. The GRS flown over by the *Apollo 15* and *16* spacecrafts mapped the entire region of the Moon that was about 20% of the lunar surface in all. Maps of the distribution of Fe and Ti for most of the Moon's surface were later derived by analysing visible and near-infrared images.

The volume of KREEP lithologies underlying the Procellarum KREEP Terrane has been estimated at 2.2 x 10^8 cubic km. With REO of < 0.5% in the Procellarum KREEP Terrane the potential REE reserves are at ~2.25 x 10^{14} - 4.5 x 10^{14} kg; the most ubiquitous REE mineral phases are apatite, merrillite (a Ca-phosphate mineral) and monazite. Although the REE concentrations in the Procellarum KREEP Terrane are beyond economic viability at the moment for mining, they represent potential future resources.

Space Weathering

The lunar surface is now known to be mostly covered by a layer of debris, called Regolith, of thickness ranging from 5 to 15 metres on the Maria. The upper part (a few mm) of the Regolith appears to have been space-weathered. The chemical composition is essentially basaltic. Space weathering (Fig.5) is a term used for a number of processes that act on any celestial body exposed to the harsh space environment. Space weathering processes act directly on the lunar surface because the moon neither has a magnetic field nor a thick atmosphere to shield the surface from incoming charged particles and micro-meteorites. Space weathering results in strong physical and chemical alterations or maturation of the regolith, involving lithification, mechanical comminution, melting, vaporisation, formation of agglutinates, ion implantation and sputtering. Several products of this maturation are scientifically important and could be economically significant, including trapped solar wind particles and cosmogenic nuclei resulting from GCR.

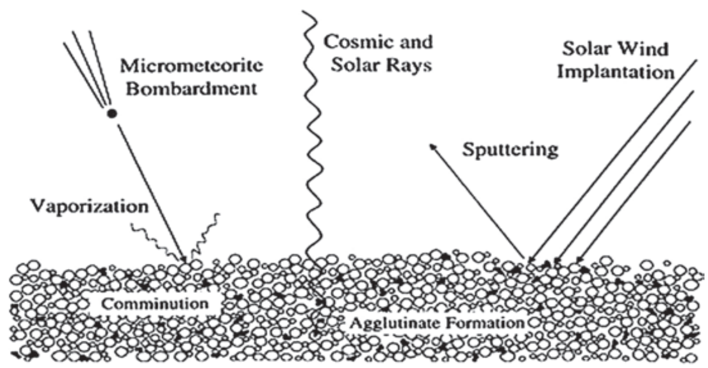

Fig.5 *Various components of space weathering (image: New World Encyclopaedia)*

Helium-3 (^3He)

Helium on the earth is of primordial origin, a remnant of planetary accretion. It has various industrial applications beyond filling party balloons Fig.6). 99.99 % of natural helium is ^4He, a stable (non-radioactive) isotope of the element. ^3He is another stable isotope that forms the rest of natural helium. ^3He is a light, stable isotope and is a potential future nuclear energy resource. There is very little ^3He available on the Earth, but is a 100 million times more abundant on the lunar regolith; the earth's atmospheric budget of ^3He is only 3,828 tonnes. Traces of primordial ^3He oozes out of the earth's interior through hydrothermal vents, hot springs and volcanoes that is eventually lost from the atmosphere into space. One of many problems associated with using ^3He for nuclear fusion is its rarity on the earth. ^3He is, however, emitted by the sun within its solar winds and reaches the lunar surface unhindered and has been accumulating there for billions of years. The earth's atmosphere and magnetic field prevent any of this ^3He from arriving on the earth. However, as the moon does not have an atmosphere and magnetic field, there is nothing to stop ^3He from arriving on its surface and being absorbed by the lunar soil. As a result, it has been estimated that there are around 1,100,000 metric tonnes of ^3He on the surface of the moon down to a depth of a few metres valued at several trillion dollars that can, if exploited, meet human energy requirement for at least 10,000 years. This ^3He could potentially be extracted by heating the lunar dust to around 600° C, before bringing it back to the Earth to fuel nuclear fusion power plants on earth. With a tonne of ^3He valued at $3 billion it is hardly surprising that a serious interest is being taken in lunar ^3He. But there are numerous practical difficulties of mining the resource on the moon; roughly one million tons of lunar soil is needed to be mined and processed for every 70 tonnes of ^3He yield, followed by bringing the precious cargo back to the Earth.

***Fig.6**. The stuff of party balloons, helium has many applications, one of which is a potential future fuel for fusion energy*

^3He is also produced as a by-product of the maintenance of nuclear weapons, which could supply around 15 kg a year. However, the temperatures required to achieve ^3He fusion reactions are much higher than in traditional fusion reactions.

^3He, is the ideal material to fuel fusion reactions when fusion technology becomes practical when the noon will be a priceless resource, since it is by far the best source of ^3He anywhere in the Solar System. Over the years, The United States, Russia and China have announced their intentions to prospect for ^3He on the moon, and to set up potential mining operations. But only China has significant plans with its Chang'e lunar exploration program that has the goal of sending astronauts to the moon by the early 2020s. One goal of India's upcoming space probe is to locate deposits of ^3He.

Basics of Nuclear Power Generation

All nuclear power plants use nuclear reactions to produce heat to turn water into steam that in turn drives a turbine to produce electricity. Current nuclear power plants have nuclear fission reactors in which uranium nuclei are split apart. This releases energy, but also radioactivity and radioactive spent nuclear fuel waste; the spent fuel is reprocessed into uranium, plutonium and radioactive waste which have to be safety and effectively stored.

An alternative way of tapping nuclear energy is by nuclear fusion reactions wherein atoms are fused at exceptionally high temperatures. The fusion reaction generates enormous energy unlike fission. Despite intense research for over half a century to make nuclear fusion reactors it has not materialised yet. In current nuclear fusion reactors, the hydrogen isotopes tritium (^3H) and deuterium (^2H) are used as the fuel that creates helium and a neutron, releasing heat energy. Nuclear fusion effectively makes use of the same energy source that fuels the Sun and other stars, but does not produce the radioactivity and nuclear waste that is the by-product of current nuclear fission power generation. However, neutrons released by nuclear fusion reactors fuelled by tritium and deuterium lead to significant energy loss and are extremely difficult to contain. One potential alternative may be to use ^3He and deuterium as the fuels in fusion reactors. The fusion of ^3He and deuterium creates normal helium (^4He) and a proton, which wastes less energy and is easier to contain. Nuclear fusion reactors using ^3He could therefore provide a highly efficient form of nuclear power with virtually no waste and no radiation.

The Chinese Lead the Way

Chinese scientists are reported to have developed a nuclear fusion device that will pave the way for generation of clean energy, similar to the real Sun. The actual name of China's *artificial sun* is called the HL-2M (Fig.7), and was built by the China National Nuclear Corporation and the South-Western Institute of Physics. The reactor is located in Leshan, Sichuan Province. The fusion device can actually reach temperatures 200 million degrees Celsius, 13 times hotter than the sun. By comparison, the Sun's core temperature is only 15 million degrees Celsius. For achieving these, the scientists use a doughnut-shaped chamber known as a tokamak. A tokamak (a Russian term) is a device which uses a powerful magnetic field to confine a hot plasma. The tokamak is one of several types of magnetic confinement devices being developed to produce controlled thermonuclear fusion power. The HL-2M uses hydrogen and deuterium gas as fuel to simulate a nuclear fusion reaction by injecting them into the device and producing plasma.

Fig.7. *The HL-2M is hotter than the real sun. (Photo: Xinhua, South China Morning Post)*

The Space Law

Mining the moon may be technically feasible in a decade or two, but does space law permit mining of the moon or exploiting any heavenly bodies? Substantial legal issues will have to be addressed before any kind of mining could take place in space. The moon or any celestial body does not matter to anybody till its resource potentials become apparent. The international laws are not very clear about utilization of outer space or ownership of resources therein. The UN Outer Space Treaty, 1967, forms the basis of international space law which stipulates that "outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means". Obviously, there is imminent need for global cooperation in this emerging scenario to enact globally acceptable regulations; otherwise, it would be Star Wars for real. The UN Outer Space Treaty-1967 will have to be expanded/modified for the sustainable benefit of all humans and life on earth. India's Lunar Missions can keep our stakes upfront, duly buttressed with leading research efforts on extra-terrestrial mineral exploration and ways to extract and transport.

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OBITUARY

Shri Man Mohan Sharma
(18/04/1949 - 19/03/2021)
LM/3709/Raj.-Jai

Shri Man Mohan Sharma was born on 18th April 1949 at Alwar, Rajasthan. He did his schooling at Alwar and obtained his degree in Mining Engineering in the year 1971 from the University of Jodhpur, MBM Engineering College. "Services by wife, two sons and family."

He worked with Coal India from 1971 to 1980 and then joined DGMS in April 1980 as Deputy Director Mines Safety and rose to the position of Director General, DGMS. He superannuated in April 2009. After an illustrious service period, Shri Sharma became MEAI member. He was amongst founder members of Rajasthan Chapter- Jaipur and his active contribution in various activities of the Chapter and Mining Welfare Centre Project will always be remembered with fond memories.

The members of the Association extend their heartfelt condolences to his bereaved family and pray for his soul rest in peace.

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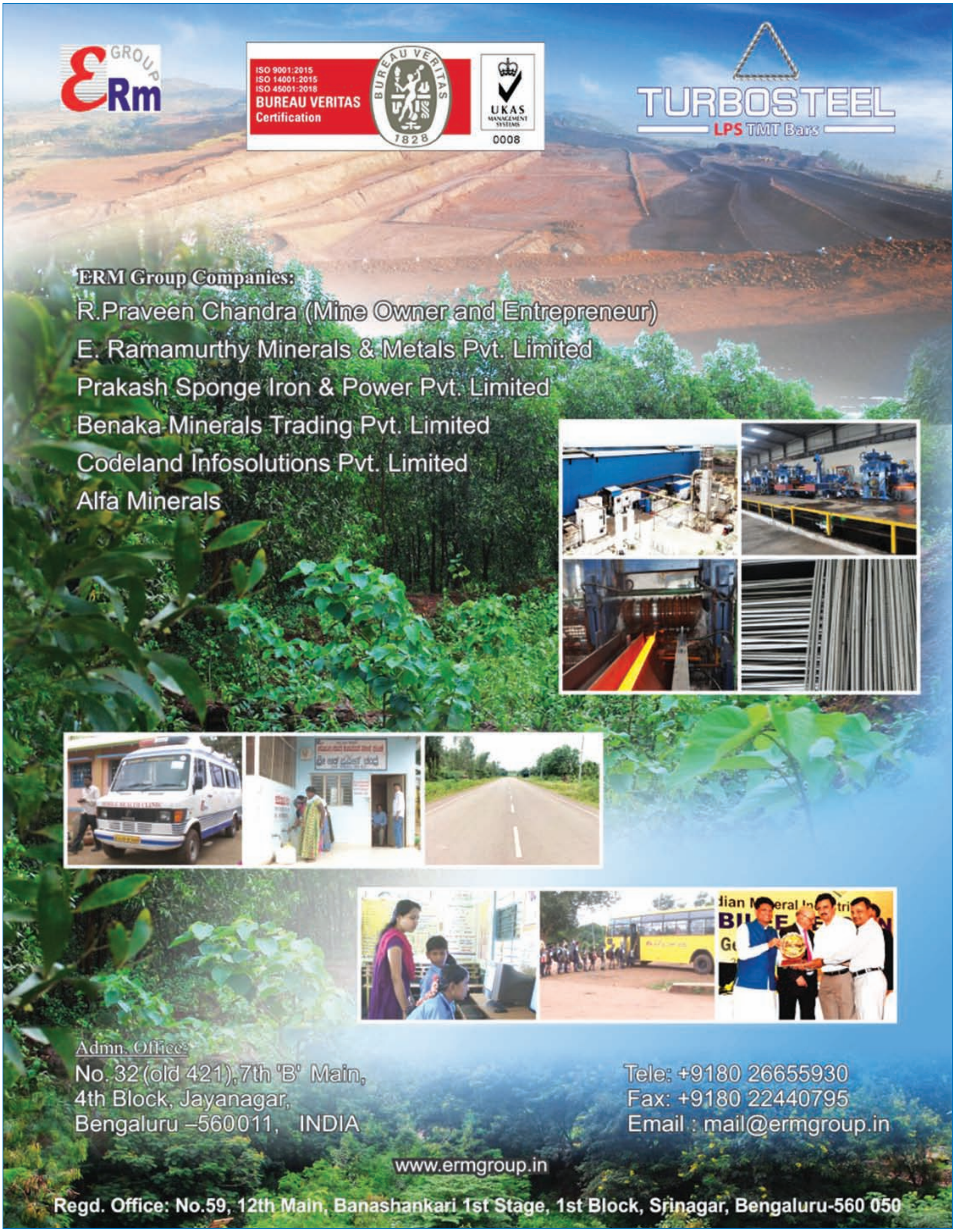
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LPS TMT Bars
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MEAI NEWS

BELLAY-HOPSET CHAPTER

Online MOCK REHARSALS FOR the aspirants APPEARING FOR first class and second CLASS MINE managers' competency examination (VIVA-VOCE)

Ballary-Hospet Chapter has organized online Mock Rehearsals for the aspirants of First/ Second Class Mine Managers' Certificate of Competency (Oral) Examinations. The objective of this program was to guide the candidates on how to prepare for the Viva-Voce (Oral) examinations conducted by the Directorate General of Mines Safety.

The webinar held for 2 days on 5-6 March 2021 witnessed enrolment of a 140 candidates out of which 120 aspirants attended. Shri. K. Madhusudhana the National Vice President-I, MEAI, Shri. K. Prabhakara Reddy, the Chairman of the Bellary-Hospet Chapter, and Shri Ajay Kumar Jain, Chairman of MEAI Veraval - Porbandar Chapter inaugurated the program.

The Bellary-Hospet and Veraval-Porbandar Chapters invited eminent speakers, who were not only well experienced in the industry but also into policymaking, to present their lectures for two days to develop comprehensive knowledge of the aspirants appearing for the Viva-voce (Oral) Examination being conducted by DGMS for the First & Second Class Manager's Competency.

The following speakers shared their knowledge:

1. Shri. V Lakshmi Narayana (Ex. Dy. DGMS) deliberated on the Standards (Bylaws) of Viva-Voce & Tips on how to prepare for Viva-voce (Oral) Examinations.
2. Shri. Ajay Kumar Jain, (HOD Mineral Resources, Ambuja Cements) deliberated on The Metalliferous Mine Regulations 1961.
3. Shri. Navneet Kumar Nuwal (Ex. Jt. President Ambuja Cements) deliberated on Management.
4. Shri. Rangantheeshwar (Ex. Dy. DGMS) deliberated on salient features of Draft Amendments in MMR, 2019.
5. Shri. R. Subramanian (Ex. DGMS) deliberated on how to prepare for oral examination
6. Shri. A.R. Vijay Singh (CA & FCC) deliberated on OVERVIEW OF OSH&WC CODE 2020 & DRAFT OSH&WC (Central) RULES, 2020.
7. Shri. Laltendu Behera (Ex Mine Head Raymond Cements) deliberated on Statutory requirements and compliance on mine safety for contractor workers.

Shri. Prabhakar Reddy, Chairman Bellary-Hospet Chapter and Shri Ajay Kumar Jain, Chairman, Veraval-Porbandar Chapter proposed vote of thanks to all presenters and heartfelt thanks to Shri. K. Madhusudhana, the National Vice President-I, MEAI who took the initiative and time for having taken up this Herculean task of bringing the Experts on to a single platform. Also expressed thanks to the Mine Magma team for successfully organising the webinar.

All the Presentations & Videos have been shared with the registered aspirants, and Presentation videos are being uploaded to YouTube for the benefit of all those who missed the session.

HYDERABAD CHAPTER

Report on One Day Seminar on 'Experiences and Opportunities for Mining Engineers in Mining Industry, Academia & Research'

A one day seminar on 'Experiences and Opportunities for Mining Engineers in Mining Industry, Academia and Research' was organized by Student Chapter of MEAI, MREC (A), MEAI, Hyderabad Chapter on 8th February, 2021 in association with Department of Mining Engineering, Malla Reddy Engineering College.(Autonomous).

Over 150 Mining Engineering students attended the Seminar from Malla Reddy Engineering College, Osmania University etc. The purpose of holding the seminar was to create awareness in mining engineers about the opportunities and share experiences from veterans in the field of Mining Engineering.

In the inaugural session, Prof. A. Ramaswamy Reddy, Director MREC(A) welcomed the guests and emphasized about the importance of the subject of seminar. He advised the students to learn about the employment and self-employment opportunities and become better mining engineers, which will bring good image and fame to the institution. He thanked the guests for their presence and MEAI Hyderabad chapter, for sponsoring this seminar.

Prof A. Ramaswamy Reddy welcoming the guests

Later the guests inaugurated the seminar by releasing the Souvenir containing presentations of speakers.

(L-R) Dr. P. Srihari, Shri N. Sri Chandrahas, Dr. M. S. Venkataramayya, Shri. V. Balakoti Reddy, Shri. B. R. V. Susheel Kumar, Shri D. N. Prasad, Dr. A. Ramaswamy Reddy, Shri K.Venkata Reddy, Dr. K. Srinivas, Prof. N. S. R. K Prasad, Shri. P.T. Naidu

The Chief Guest Shri D. N. Prasad, Advisor SCCL, delivered keynote address. He outlined the projected view and growth potential in mining industry, in its various sectors. He presented best ways to do career planning, employment scope for mining engineering graduates in the Government, Central/State Public Sector Undertakings, and Academic & Research Institutions and in Private Sector in both coal and non-coal mining. In case of private sector, he outlined the opportunities in the upcoming Mine Development Operator culture and employment.

Guest of Honor Shri B. R. V. Susheel Kumar, Chairman Hyderabad Chapter outlined the investment opportunities for new entrepreneurs in the minor mineral sector. He advised the students with good basic knowledge; common sense and confidence in themselves can become entrepreneurs. With a flow chart the entire process of obtaining Quarry Lease, was explained. He said that manufacturing sand by crushing stone and engineered stone offers wide scope for future business.

- In the second part, he gave a handout on the subject of 'Innovation through startups in Mining & Mineral Sector' a way of contribution towards the National movement of "Atmanirbhar Bharat". He presented how SATYBHAMA portal facilitates and encourages startup and research culture.

A section of audience participating in the seminar

Later Shri K.Venkata Reddy, Head Operations, Trident Chemphar Ltd, Mozambique outlined career opportunities in mining for fresh graduates in Mozambique as well as in India. He explained that his company is going to have openings in Mozambique Coal operations, opencast and underground operations in Coal in India, Quartzite and Dolomite mines, in near future.

Shri. V. Balakoti Reddy, Chief Operating Officer, BGR Mining Infra Limited had given inputs to students regarding how to work hard get adjusted to field conditions for building a successful career.

Coordinator Dr. M.S. Venkataramayya, Dean IIIC & Prof Mining Engineering thanked the Hyderabad Chapter for sponsoring the Seminar. Prof. K. Srinivas, HoD Mining thanked MREC management and guests for attending program while proposing vote of thanks. Sri N.S.R. Krishna Prasad, Asst. Professor conducted the program including the introduction of guests etc.

Director Dr. A.Ramaswammy Reddy felicitated the speakers with mementos.

RAJASTHAN CAHPTER-UDAIPUR

Report of virtual talk on 'Occupational Safety, Health & Work Conditions Code, 2020 – A View Point'

With the cherished objective to create awareness amongst mining fraternity and industrial workforce about the key amendments brought-in through an OSH Code, the Rajasthan Chapter -Udaipur covering the recent changes in the mining laws, a technical talk / virtual talk on 'Occupational Safety, Health and Work Conditions Code, 2020 – A View Point' was organized on 7th March, 2021.

At the very outset Shri YC Gupta, Chapter Chairman welcomed all the members, speakers Shri RP Dashora, COO(Tech) HZL and Shri AK Porwal, Ex-DMS, Udaipur with the hope that this programme will help in creating the awareness and better understanding.

Shri Akhilesh Joshi, Patron MEAI, Udaipur spoke about the contribution of mining in country's growth. He emphasized on the needs/ importance of mineral discovery in accelerating the growth of the mineral industry besides safety, health & environment.

(L-R) Dr SC Jain, Jt Secretary, Sh RP Dashora, COO (Tech.) HZL, Sh MS Paliwal, Secretary & Sh AK Porwal, Ex-DMS

Presentation by Shri AK Porwal, Ex DMS-Udaipur region

Shri Porwal has briefed about the background and history for the recent changes in the mining laws on occupational health and safety and working condition. The bill was passed by the Lok Sabha on 22nd September, 2020 and Rajya Sabha on 23 September, 2020. The bill received Presidential Accent on 28 September, 2020.

The salient features of the OSH Code-2020 are as under: The Labour laws are amalgamated in to five groups including industrial relations, Wages, social security and Welfare & working conditions. 13 central labour enactments relating to varied coverage of industrial regulations.

Every employer of any establishment has to be electronically registered within 60 days from the date of applicability

To provide health examination & safe working environment

Ensure disposal of hazardous /toxic waste including disposal of e-waste

If accident occurs leading to death/ injury covering absent from working of >48 hrs shall send notice to such authority. Apart from this dangerous occurrence and any disease out of 29 diseases notified by the government shall be informed.

Shri Porwal concluded with the remark that government has simplified the laws.

Presentation of Shri RP Dashora, COO (Tech.) HZL

Shri RP Dashora touched upon the key role of skills & indepth knowledge of persons working in the mines about the processes, equipments & applicable laws. He emphasised Engineers/ Supervisors needs to hold the accountability and need to upgrade through regular trainings, embracing changes in technology, safety & health norms. He added that Code incorporated 633 provisions of 13 major labour laws into one single Code with 143 provisions.

At the outset he highlighted the salient features of the Code applicable to establishment/ mines. He told that the provision of the code will definitely reduce the burden of enterprises & employers and database creation, digitalization will bring the industry on to a single platform to analyze the data repositories in the best manner. Annual health check-up, appointment order of each employee by employer, disposal of e-waste and the appointment of welfare officer over the employment base of 250 persons are the key features of the Code. Since the MSW persons are not available, MBA qualified persons may also be given opportunity as welfare officers under the statute.

Shri RP Dashora heartily welcomed all the participants, audience and vehemently thanked the Rajasthan Chapter-Udaipur for providing the platform to acquaint with and discuss on the recent Code applicable to mining industry.

Prior to this, Dr SK Vashisth, Dy GM-HZL & NC Member briefly introduced Shri RP Dashora, as illustrious Mining Engineer having over 33 yrs experience in both the opencast and UG operations across commodities and global geographies having worked extensively at Armenia Gold as head (Tech Service) and visited Australia, Zambia and several countries. He is an elite member of CSIR's CIMFR Board and represented various committees in the ministry and mining institutes. Recently he has been nominated as member of DGMS Committee.

Dr SK Vashisth also introduced Shri AK Porwal as BE Mining, besides MBA and holding FCC both Coal & Metalliferous(UR) in 1986, 1987. He Joined HZL for initial years and later shifted to DGMS and finally superannuated as DMS-Udaipur region.

(L-R) Dr SC Jain, Shri MS Paliwal, Shri AM Ansari , Shri AK Porwal, Shri OP Soni and Shri MK Mehta. A section of participants on the occasion.

The programme was coordinated by Shri MS Paliwal, Secretary, MEAI-Udaipur. He thanked Shri Dashora and Shri Porwal for their eloquent & insightful presentations, besides the participants. The talk was physically attended by 24 and virtually by 42 members.

The Programme was concluded with the vote of thanks proposed by Shri OP Soni, Vice-Chairman, Rajastahn Chapter-Udaipur.

A wide publicity of the program was made through print & electronic media through coverage in local newspapers, social media among the students, members, entrepreneurs and the stakeholders.

Book Written by Shri P.K. Govindaswamy

'MEMOIRS OF A MINING ENGINEER'

Shri P.K. Govindaswamy (LM.NO:628/TN) Joint General Manager (Retd) of L&T has published a Book 'Memoirs of a Mining Engineer' in the year 2020, wherein he has narrated his experiences right from the beginning of his carrier till his retirement in the field of Mining.

His experiences and views may prove valuable for the budding Mining Engineers who have keen interest in the Mining and the Construction fields.

(M. Narsaiah)
Secretary General, MEAI

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NACRI
NATIONAL COMMITTEE FOR REPORTING MINERAL RESOURCES AND RESERVES IN INDIA

REFRESHER COURSE BY
GEOGLOBAL, LLC (USA)
A LIVE ONLINE REFRESHER COURSE ON MINERAL RESOURCE ESTIMATION AND APPLIED GEOSTATISTICS

Dates: **10 - 19 May 2021**

Sponsoring organization: **GeoGlobal, LLC (USA)**

This is a competency building & professional development program developed for mineral industry professionals. Reputed International experts from mineral exploration and mining will conduct the course lectures along with practical examples.

The short-course program covers the following key topics

Project development and studies in mining project development, Ore-forming Systems, Mineral Resource Estimation (data quality, data management and exploratory data analyses, Variography, Grade estimation and resource classification), Role of QP and various international reporting codes, and Geological risk analyses in resource estimation.

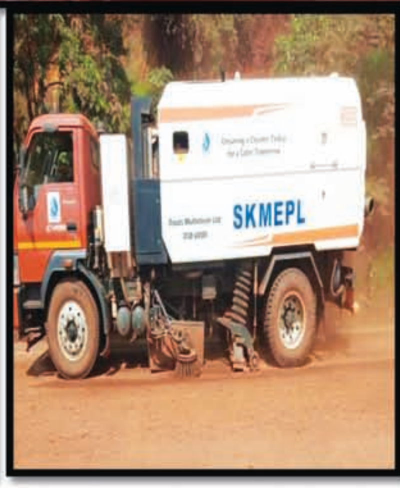
Limited number of attendees allowed.

Hours of learning activity (excluding registration, breaks, etc.): 20

Name(s) of Instructors (please attach vita): Dr Abani R Samal

About the instructor

Dr Abani R Samal holds M. Tech degree from IIT(ISM), Dhanbad, MS and DIC from Imperial College, London and PhD from SIU-C, USA. He has nearly 25 years of experience in the mining industry. Dr Samal is an expert in mineral deposit studies, resource estimation & reporting, applied geostatistics and mine to mill reconciliation. Currently he is the owner and Principal of GeoGlobal LLC in USA. He is a council member of MEAI, fellow of GSI (India), a Fellow of SEG, registered member of the SME and a certified professional geologist (CPG) of AIPG.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CONFERENCES, SEMINARS, WORKSHOPS ETC.

ABROAD

28-30 Apr 2021: Life of Mine Conference 2021. Venue: Brisbane, Australia. Organized by AusIMM, Ground Floor, 204 Lygon Street, Carlton South, Victoria 3053 Australia. Telephone: +61 3 9658 6100.

New Online Course on Introduction to Blasting by Edumine. Course details: Presenter - Dr. Anthony Konya. Duration: 3 hours, Learning Credits: PDH 3.0, Format: Short video modules. For registration contact. News@edumine.com

10-11 Jun 2021: **ICAME 2021- International Conference on Applied Mineralogy and Environment** in Copenhagen, Denmark. For more details, please visit: https://waset.org/applied-mineralogy-and-environment-conference-in-june-2021-in-copenhagen

15-16 Jun 2021: **International Conference on Mining Geology and Coal Exploration ICMGCE** in Toronto, Canada. Website URL: https://waset.org/mining-geology-and-coal-exploration-conference-in-june-2021-in-toronto; Contact URL: https://panel.waset.org/Support

23-25 Jun 2021: **MILL OPERATORS CONFERENCE 2021**. Online conference organized by AusIMM Brisbane, Australia

29-30 Jun 2021: **ICAG 2021 - International Conference on Advances in Geochronology** in Dubai, United Arab Emirates. For more details, please visit: https://waset.org/advances-in-geochronology-conference-in-june-2021-in-dubai

1-2 Jul 2021: **MINE WASTE AND TAILINGS CONFERENCE 2021**. Online conference organized by AusIMM Brisbane, Australia

26-27 Jul 2021: **OPEN PIT OPERATORS CONFERENCE 2021**. Online conference organized by AusIMM Perth, Australia

22-23 Jul 2021: **International Conference on Mining and Economic Geology ICMEG** in Berlin, Germany. Website URL: https://waset.org/mining-and-economic-geology-conference-in-july-2021-in-berlin; Contact URL: https://panel.waset.org/Support

22-23 Jul 2021: **International Conference on Geology, Mineral Exploration and Mining ICGMEM** in Rome, Italy. Website URL: https://waset.org/geology-mineral-exploration-and-mining-conference-in-july-2021-in-rome; Contact URL: https://panel.waset.org/Support

23-24 Aug 2021: **ICCGG 2021 - International Conference on Computational Geology and Geosciences** in Rome, Italy. For more details, please visit: https://waset.org/computational-geology-and-geosciences-conference-in-july-2021-in-rome

20-21 Sep 2021: **ICGG 2021 - International Conference on Geochronology and Geography** in Toronto, Canada. For more details, please visit: https://waset.org/geochronology-and-geography-conference-in-september-2021-in-toronto

28-29 Sep 2021: **NEW LEADERS CONFERENCE 2021**. Online conference organized by AusIMM Brisbane, Australia

6-7 Oct 2021: **ICEGGE 2021 - International Conference on Engineering Geology and Geomorphology Engineering** in Beijing, China. For more details, please visit: https://waset.org/engineering-geology-and-geomorphology-engineering-conference-in-october-2021-in-beijing

18-19 Oct 2021: **ICEG 2021 - International Conference on Earthquake Geology** in Rome, Italy. For more details, please visit: https://waset.org/earthquake-geology-conference-in-october-2021-in-rome

21-22 Oct 2021: **ICRSSGA 2021- International Conference on Remote Sensing Sensors for Geoscience Applications** in Athens, Greece. For more details, please visit: https://waset.org/remote-sensing-sensors-for-geoscience-applications-conference-in-october-2021-in-athens

8-10 Nov 2021: **IRON ORE CONFERENCE 2021**. Online conference organized by AusIMM Perth, Australia

8-9 Nov 2021: **ICEGGP 2021 - International Conference on Environmental Geology and Geological Problems** in Istanbul, Turkey. For more details, please visit: https://waset.org/environmental-geology-and-geological-problems-conference-in-november-2021-in-istanbul

2-3 Dec 2021: **ICRMGEA 2021 - International Conference on Rock Mechanics for Geotechnical Engineering Applications** in Tokyo, Japan. For more details, please visit: https://waset.org/rock-mechanics-for-geotechnical-engineering-applications-conference-in-december-2021-in-tokyo

6-7 Dec 2021: **ICCGM 2021 - International Conference on Computational Geosciences and Mathematical Modelling** in Kuala Lumpur, Malaysia. For more details, please visit: https://waset.org/computational-geosciences-and-mathematical-modelling-conference-in-december-2021-in-kuala-lumpur

6-8 Dec 2021: **INTERNATIONAL FUTURE MINING CONFERENCE 2021**. Online conference organized by AusIMM Perth, Australia

13-14 December 2021: **ICRGGACS 2021 - International Conference on Regional Geology, Geologic Analysis and Computer Simulations** in Cairo, Egypt. For more details, please visit: https://waset.org/regional-geology-geologic-analysis-and-computer-simulations-conference-in-december-2021-in-cairo

15-16, April 2022: **ICGGG 2022 - International Conference on Geochronology, Geology and Geophysics** in Cape Town, South Africa. For more details, please visit: https://waset.org/geochronology-geology-and-geophysics-conference-in-april-2022-in-cape-town

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