

A person wearing a full-body mining suit and a headlamp with a bright yellow light is walking away from the camera down a long, arched tunnel. The tunnel walls are constructed from reddish-brown bricks, and the floor is dark and reflective. The perspective is from behind the person, looking down the length of the tunnel.

THE NEW ERA OF MINING

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The New Era of Mining



robust global mining industry is essential for a growing green economy. Some facts to bear in mind: a solar panel requires aluminum, steel, copper, zinc, and silver. A wind turbine: steel, copper, and aluminum. An EV battery: lithium, gold, silver, cobalt, manganese, aluminum, nickel, and copper. These raw materials are now commonly known as the critical metals. As per the World Bank, these could experience a fivefold increase in demand by 2050, driven by the growing requirements of clean energy technologies. The supply shock has already prompted new political legislation in the U.S., Canada and Europe, and the security of domestic supply will be a major talking point in the 2024 presidential election - reminiscent of the 1979 Iranian oil crisis which saw Reagan swing the lead. In this context, considering recent geopolitical events such as the war in the Ukraine and the deteriorating relationship between the West and China, security of supply is a central concern of the West.

Ramping up the production and adoption of green power is key to reaching CO₂ reduction targets; therefore, ramping up our domestic metal supply is more prescient than ever. To meet the needs of the modern world, an estimated \$1.7 trillion in global mining investment is anticipated. Furthermore, as pointed out by Quinton Todd Hennigh, CEO of Minera San Cristóbal, the increasing demand for metals transcends green technologies, given that “we have a growing global population and many people have transitioned into lifestyles that depend on more metals over time, regardless of the electrification movement.” This upheaval in demand has consequenced a radical shift in the industry: not simply to ramp up extraction, but also to enhance the processes which make the industry more sustainable. In this report we present the essential facts and figures of this New Era of Mining, and set out the main political and structural challenges ahead. The insights showcased here are based on over 100 in-depth interviews with the mining CEOs leading the industry forwards today.

In This Report...



TOM PALMER

CEO, NEWMONT
BIGGEST GOLD PRODUCER IN THE WORLD

“There is a consensus that we need to accelerate our efforts to address the potential gap between supply and demand in critical metals that could significantly shape the world's future. I am optimistic as I see a general consciousness and willingness to engage in these necessary discussions, yet the pace needs to be stepped up to match the urgency the situation demands.”

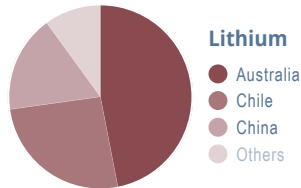
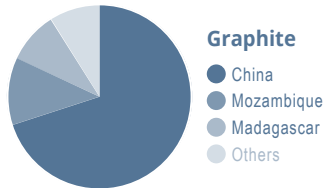
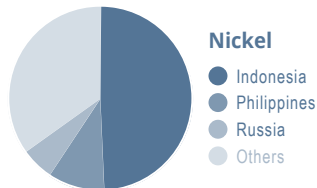
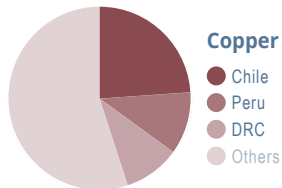


RICHARD ADKERSON

CEO, FREEPORT-MCMORAN
BIGGEST COPPER PRODUCER IN THE U.S.

“At Freeport, we are a dominant force in the U.S copper market, accounting for over half the copper mined in the U.S. We advocate for a more streamlined and efficient permitting process, which will not only uphold the existing stringent environmental and community standards but will also foster quicker responses and development of green and brownfield mines.”





Source: International Energy Agency, 2022



JON STANTON |
CEO, THE WEIR GROUP



Mining is essential in the race to net zero but the industry must adopt more sustainable operations and engage stakeholders in that shift. Technology is a critical enabler in helping mining scale up and clean up to provide the vast quantities of minerals needed for a low carbon future.

Critical Metals and the Green Transition

Clear environmental targets have been established, and their importance - alongside the catastrophic consequences should we fail to achieve them - is frequently emphasized. If we are to meet these targets, we need to intensify the extraction and processing of minerals. Electric Vehicles (EVs) exemplify this need; “An internal combustion engine uses 25 kilograms of copper, and an EV demands over 80 kilograms - to fill the gap that we have by 2030, we should be opening one and a half world-class mines every year,” explains the CEO of Fortuna Silver, Jorge A. Ganoza. Paul House, CEO of mining-tech company IMDEX, further illustrates this in regard to

its share of the overall drilling spend: “Historically, copper, cobalt, nickel, and lithium accounted for 35% of drilling spend, whereas today they account for 65% of all new projects.” When it comes to predictions regarding future copper demand, Iván Arriagada, CEO of Chilean copper giant, Antofagasta, tells us that “projections indicate an additional 6 million tons of copper will be needed as early as 2030, a significant increase from current levels.” In addition, as stressed by the CEO of Arizona Sonoran Copper, George Ogilvie, “There is simply no suitable replacement for copper right now,” meaning that these predictions are unlikely to be far off-target.

Richard Adkerson, the CEO of American copper giant, Freeport-McMoran, states: “the increase in copper usage is a worldwide phenomenon, and it behooves us to develop strategies that cater to this



► rising demand.” An exemplary case of such strategies emerges from no less than America’s biggest gold miner, Newmont. The company has recently acquired Australian gold and copper mining company Newcrest for \$19 billion. Newmont’s CEO Tom Palmer, outlines the reasons for this massive move into the copper space: “Our Newcrest acquisition strategically tops our list given their tier-one operations globally, their prominent presence in Australia and Canada, and their existing and potential growth in copper production.”

Lithium, the lightest and most reactive metal, is the major ingredient of the battery industry. The appetite for EVs - from around 4% of total car sales in 2020 to 14% in 2022 - translates to an increase in demand for lithium, necessitating greater extraction and processing. Sigma Lithium’s CEO, Ana Cabral-Gardner, reveals that “for nearly four years, from 2018 to mid-2021, zero dollars flowed into the lithium industry, but we kept investing. We believed in the fundamental market drivers and stayed the course, and now it’s all playing out.” Cabral-Gardner’s insights shed light on how some metals underpinning the celebrated green transition have faced historical undervaluation and neglect. Consequently, the lithium market could face potential shortages, as elucidated by Killian Charles, CEO and President of Canadian lithium explorer, Brunswick Exploration. Charles asserts

Leading Voices



MARK BRISTOW | CEO, BARRICK GOLD

My view is that if you want to be a modern-day miner, you need to understand that you are managing a national asset, and it really belongs to the nation.



MARNA CLOETE | PRESIDENT, IVANHOE

As we move towards this widely reported looming copper deficit, we will need to have companies that can execute projects quicker than in the past. The days when a mining project took 25 years from proposition to implementation are over. We need to meet the overwhelming demand for raw materials.



IVÁN ARRIAGADA | CEO, ANTOFAGASTA

Centinela is a hub for innovation, running solely on renewable energy and featuring our first autonomous truck fleet.



RAYMOND GOLDIE | PRESIDENT, PDAC

The dynamic price of lithium markets is proof that markets are still trying to figure out how global decarbonization and electrification will factor into mineral and commodity markets.



BRENT BERG | CEO,
RARE ELEMENT
RESOURCES

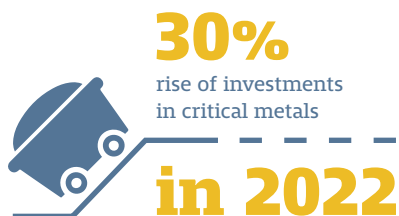


China’s rare earth monopoly poses a serious risk to our nation. To address this, we must develop more projects like Bear Lodge and innovate new technologies, like our proprietary recovery process. Sustained collaboration between industry and government is the best way to ensure a secure supply chain.

that “the current supply base for lithium doesn’t match the burgeoning demand, and has led to its prominent market boom. While ample known deposits make it feasible to increase copper production, the same doesn’t hold true for lithium.” The heightened value of Lithium may well bring along one of the best investment opportunities of the decade, and many companies are actively pursuing innovation in this field to enhance production. One of the most ingenious of these innovations comes from Volt Lithium, who, according to Alex Wylie, President & CEO, “discovered that numerous oil fields across North America are already producing lithium.” Volt consequently developed a technology to produce lithium out of oilfield brine, “spearheading the technology and achieving over 90% extraction recoveries with brine of 34 parts per million concentration, while also removing contaminants from oilfield brine in the process.”

Last but not least, the rare earths needed for the transition and overall economy alike, capture the attention of countries looking to rival China’s dominance. As Brent Berg, CEO of Rare Element Resources elaborates, “rare earths provide vital inputs for a vast range of future-facing products. They are well-known for their unique magnetic, phosphorescent, and catalytic properties, which enable technologies like infrared absorption in night vision goggles, and the high-powered magnets you find in smartphones, computers, wind turbines and EV motors.” A potential inconvenience for the West is that China accounts for 63% of all rare earth mining, 85% of processing, and 92% of rare earth magnet production, as per Politico. Western companies have been expanding the search for rare earths across the world in order to counteract this monopoly. The U.S., Australia, and Myanmar collectively make up 24% of the world’s total throughput of rare earth metals, and are China’s best-placed competitors. An iconic example is that of Australian Iconic Rare Earths, which has ventured into Uganda to ramp up rare earth production. CEO Tim Harrison shares that their Ugandan location, “Makuutu, stands unique, being unconnected to China and poised to address immediate demand from the West. The project has the potential to be a multi-decade producer of magnet and heavy rare earths, which are crucial for the new economy.





Source:
International Energy Agency, 2023

Precious Metals: Gold and Silver

Besides its central role in the green transition, precious metal mining is a bastion of the global economy, and the wherewithal hedge of economic stability. As a tangible investment amidst renegeing cryptocurrencies and geopolitical unrest, the gold industry is enjoying prosperity at present - as it has already experienced many times throughout the last 6,000 years. Additionally, renewed interest from younger generations trading digitally has spurred new investment. John McCluskey, CEO of Alamos Gold, recounts: "It is important to understand the circumstances when Alamos Gold started around 2003. Then, the gold price was below \$300 per ounce, making it nearly impossible for companies to turn a profit." Gold currently stands at just under \$2000 per ounce. Since then, gold prices have experienced an upward trend, however the path has been fraught with obstacles. Equinox Gold's CEO, Greg Smith, tells us, merely a year ago "the gold value decreased from almost \$2,000 to \$1,600 per ounce and. At the same time, gold companies around the world were experiencing significant inflation, which was reflected in the cost of fuel, consumables necessary for processing, and higher wages." But as markets evolve, the resilience and adaptability of the industry are evident. The intrinsic faith in the worth of gold instills confidence in individuals and institutions alike to trust gold as a secure repository for their funds. As such, "by the end of last year cost inflation had flatlined and, ever since, the gold price has stayed pretty stable in the \$1,900 per ounce range" placing most gold miners in "a profitable position."

What are the forces pushing this upward trend? Firstly, According to the World Gold Council's CEO, David Tait, "over this last quarter we have seen central banks in developing markets persistently buying gold, showing a high degree of pragmatism in light of geopolitical turmoil." Furthermore, Eldorado Gold's CEO and president, George Burns, has pointed to the shift in the industry toward sustainable mining practices, claiming that it "could be instrumental for a younger generation, should they gravitate towards gold as a more stable and tangible investment, compared



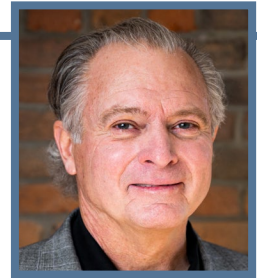


▶ with cryptocurrencies, which often have a momentum-driven nature and greater cyclicality. Gold offers a physical guarantee, which adds a layer of security to the investment.” Finally, Alamos Gold’s CEO points towards the central role of the gold industry in Eastern geographies, who “represent approximately 55% of the gold market.” He elaborates: “In countries like India and China, where gold is traditionally a part of culture and daily life, the line between retail purchases and investments is blurred. In these regions, high-carat gold jewelry is seen as an investment. The East has a deep-rooted affinity for gold, and this cultural attachment fuels demand.” The enduring security of gold in Eastern finance is a testament to its historical significance despite recent price convulsions. The current price of the only metal that doesn’t rust shows that the appeal of gold as a safe haven asset is evolving in tow with consumer trends, as Newmont’s CEO Tom Palmer articulates “gold has been a symbol of wealth and a store of value for millennia, a role it will continue to uphold owing to its well-regulated, liquid, and deep market.”

The biggest undeveloped gold resource in the world, Seabridge Gold’s KSM project, is found in the heart of British Columbia, proving that when it comes to the geographies that represent the future hotspots



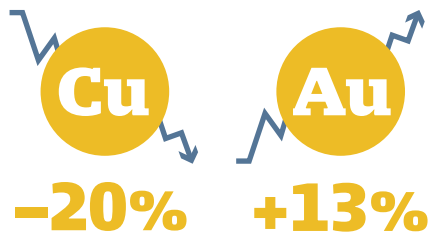
RUDI FRONK |
CEO, SEABRIDGE GOLD



Commodities have never been more underpriced compared to financial assets. Commodity stocks have never been cheaper compared to the underlying commodities. Seabridge shares give investors an unparalleled hedge against broader markets and unparalleled leverage to rising gold and copper prices.

of gold production, North America still has much to offer. From the tall timbers of Northern Canada, CEO Rudi Fronk tells us that KSM is not only “the world’s largest undeveloped project as measured by ounces of gold” but is “now also a significant player in the copper world.” KSM boasts “100 million ounces of gold and about 20 billion pounds of copper.” The presence of both gold and copper signifies the multifaceted potential of new gold mines, and the diversification of value extraction away from a traditionally monometallic focus. The KSM project also underscores the importance of long-term resource discovery in North America - sometimes one does not need to search too far from home to find what one is looking for.

Gold is not the only precious metal enjoying positive market prospects; according to the Energy Information Administration, by the 2040s silver demand could increase almost fourfold, reaching around 500 million ounces. Compared with the gold industry, the evolution of silver has been even more radical. Phillips S. Baker Jr., CEO of Hecla, the biggest silver producer in the United States, manifests that “while silver has historical uses like photography, its demand has shifted significantly. In 1999, a third of silver was used in photography, but today it’s around one twentieth.” Baker claims that silver’s potential in technology applications is what took the industry by storm: “The growth has primarily come from the electronics sector, where silver’s conductivity plays a crucial role in devices like smartphones. On top of that, each GW of solar energy capacity currently requires approximately half a million ounces of silver,” which illustrates the deep diversification that has occurred - all in an impressive time span of 2 decades. CEO of Discovery Silver, Tony Makuch, further affirms how silver’s role in the economy has changed: “While silver was historically seen primarily as an investment, approximately 50% of its current demand is for industrial use, and that percentage is likely to increase.” As the most conductive metal, the widely-agreed consensus is that the applications of silver will continue to diversify - one can only wait to see what comes next.



Price change in copper and gold since October 2021

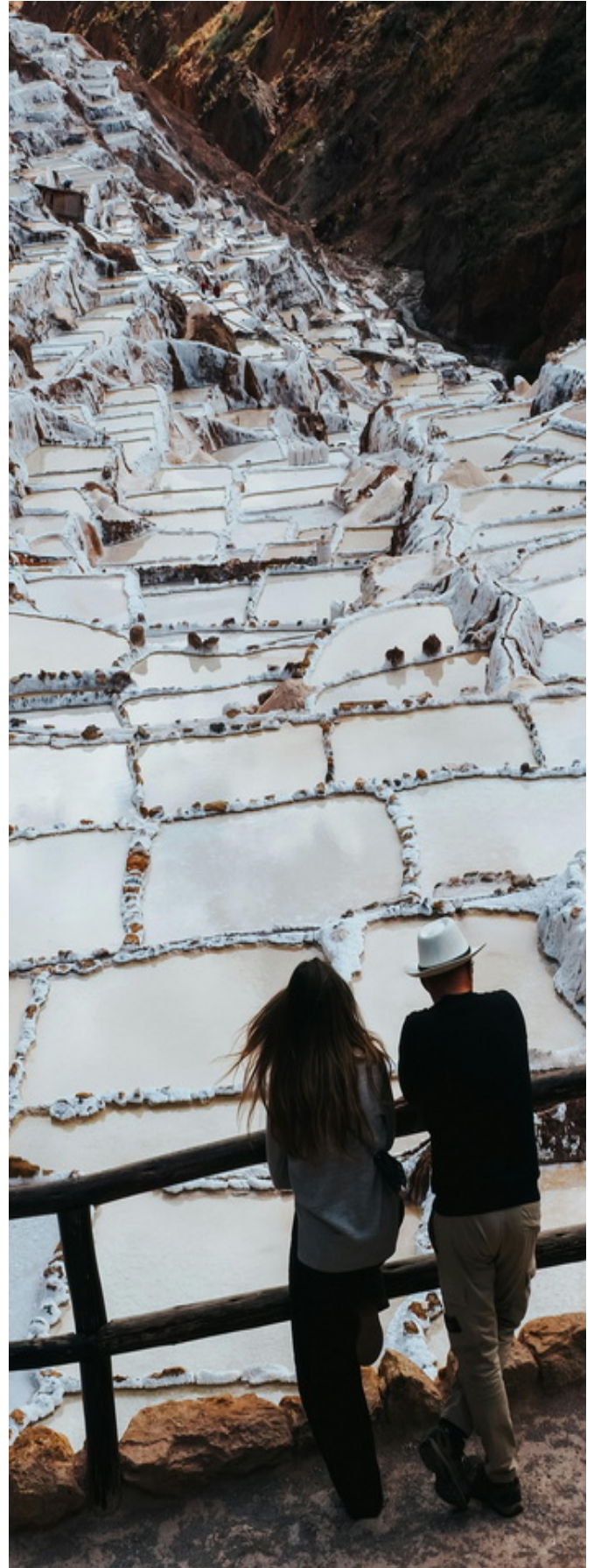
Source: Trading Economics, 2023

The Western Supply Chain

The West now confronts an imminent challenge: how best to establish a secure metal supply chain, robust against geopolitical fluctuations and conflicts? This imperative is underscored by China's profound influence in the global market. China vaunts the possession of over half of the world's lithium refining capacity, and 77% of the world's cobalt refining capacity, as reported by The Institute for Energy Research. These numbers paint a picture of a world heavily reliant on a single nation for essential resources, and expedites the urgency for the West to secure an autonomous and resilient supply network. Sam Ash, CEO of Bunker Hill, who is successfully restarting one of America's oldest and largest silver mines to meet the incoming demand, points to 2008 as a pivotal time: "The global financial crisis of 2008 wiped 50% of available capital for mining because the banks were unwilling to lend to ventures with higher risk, but between the 1990s and now, China has deployed billions of mining dollars all around the world - including in the U.S. and Canada." This problem extends all the way to the field of talent, as Dr. Dana Bennet, Interim President of the Nevada Mining Association, alarmingly tells us: "We are fortunate we still have one of the last 11 mining schools left in the U.S., but at the country level, we are not producing enough mining engineers, geologists, metallurgists and environmental scientists. In a particular semester, China would have 2,000 mining engineers studying, while Nevada has only ten."

What are the consequences of the West failing to build an autonomous supply chain? In the words of mining-engineering company TAKRAF's CEO, Thomas Jabs, "an immediate repercussion would be a surge in commodity prices, echoing previous trends witnessed in the iron ore market. Copper, pivotal for electrification and the green transition, would especially be impacted." This underscores a scenario where the West finds itself in a vulnerable position, with its green aspirations stymied by supply vulnerabilities: "Delays in new investments or dependency on politically unstable nations could compromise the supply chain, instigating a shift in alliances and dependencies. For instance, countries like China might reorient their supply chains, impacting the equilibrium of global resource distribution." For the foreseeable future, China's dominion over the sector is set to continue. As reported by Reuters, China still accounts for 80% of U.S. imports of the group of 17 minerals used in military equipment and high-tech consumer electronics - in order to parry this risk, the West must up its game, and there are several signs it is starting to do so.

In pursuit of new supply, Western entities are extending their geographical reach to the final geographies rich with untapped potential. Africa, followed by South America, emerge as the focal points. According to the Center for Strategic and International Studies, Africa contains roughly 85% of the world's manganese, 80% of all





▶ platinum and chromium, 47% of all cobalt, and 21% of all graphite. South America contains 36.4% of the world's copper. This renders expansion into these continents a great opportunity to consolidate the supply chain, whilst also fostering development and enrichment for all. Lifezone Metals is focused on nickel mining and operates in Tanzania. Lifezone's CEO, Chris Showalter, sheds light on new Western initiatives in Africa: "The U.S has initiated significant projects like the Lobito corridor (Central Africa) and the Partnership for Global Infrastructure Initiative to facilitate critical infrastructure development which supports metal mining in Africa, it's a conscious effort to strengthen their position in the global supply chain."

Deep South Resources is a copper exploration company operating in Namibia. Deep South's CEO, Pierre Léveillé, tells us that their "Haib Copper deposit hosts a resource of nearly 1 billion tons of copper." Africa's mineral wealth is not limited to the critical metals, but also extends to precious metals like gold. Richard Clark, CEO of Montage Gold, exemplifies this point, extolling the abundant opportunities within the Archean Greenstone Belt, a region that cuts across several countries in West Africa: "We were interested in the area - the Archean Greenstone Belt that includes Côte d'Ivoire, Ghana, Senegal, Mali, and Burkina Faso - by virtue of the proliferation of deposits found there. Their gold geology is stupendous."

Increasing production, however, does have environmental costs. The mining industry has faced a great deal of criticism for its detrimental effects on the environment. In 2021, the industry accounted for between 4 to 7% of global greenhouse gas emissions, as reported by GlobalData, placing it close to industries such as agriculture, which contributes 11% of global emissions. Moreover, mining operations have had a lasting and profound impact on water resources. According to MIT, it is estimated that over 180 million metric tons of mine waste flow into the world's waters annually.

However, aware of their past reputation, Western mining companies are now escalating their mission to align operations with the new ethos of environmental sustainability. There is promising new forward momentum in this regard, and innovative technologies which serve to extract minerals whilst minimizing the ecological footprint are emerging. The integration of environmental stewardship into the core of mining operations is already seeing reality on the ground. McEwen Mining's CEO, Rob McEwen, details the transformative new approach taken at their Los Azules copper project: "Our Los Azules copper project will use less than one quarter of the water, and will emit less than one third of the carbon of an average mine. By 2038, we will be net zero and utilize an electric mobile fleet, powered by 100% renewable energy."

Mining technology companies are enhancing their sustainability in all aspects of mining operations, as illustrated by Mikko Keto, CEO of mining engineering multinational, FLSmidth: "Our goal is to support all mining operations through basic automation, data analytics, sensors, and process optimization. Our technologies range from in-pit crushing and conveying to milling, grinding, flotation methods, and tailings management, among others." Scottish mining engineering expert, The Weir Group, is developing technologies aimed at dramatically reducing energy and

PIERRE LÉVEILLÉ |
PRESIDENT & CEO,
DEEP SOUTH RESOURCES



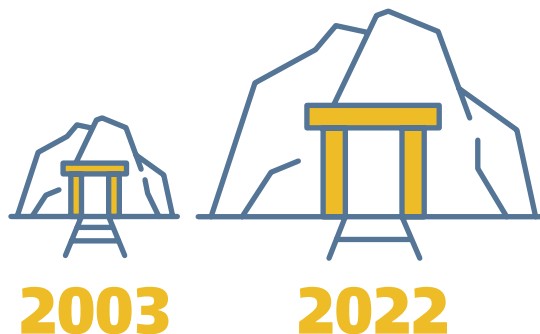
For the next 50 years, copper will be the king commodity. Without copper, we would have no transportation, no communications, and no cloud storage... and global copper markets are facing many years of huge supply deficit. We must work to develop new copper deposits now in order to secure our future.

“

TAKESHI TANIGUCHI |
VP, HEAD OF MATERIALS
BUSINESS, YOKOGAWA
ELECTRIC CORP.



Yokogawa has been developing and providing process control systems for around 50 years, and, moving forward, we aim to embrace AI technologies that will enable the industry to move to the next stage, autonomous operations.



The market cap of the Top 40 mining companies tripled from US\$400bn in 2003 to US\$1.2trn in 2022

Source: PwC, 2023

water consumption – critical components of mining sustainability. Weir’s CEO, Jon Stanton, explains their current progress: “We are developing technologies that can reduce energy consumption by up to 50% compared to traditional methods. This is a huge deal, considering that the mining industry consumes 3% of the world’s electricity. We’re also working on improving material classification and reducing water consumption via AI.”

Among the most conspicuous obstacles in the mining industry’s path towards sustainability is tailings management. Tailings, as described by the CEO of CVW Technology, Akshay Dubey, are “the waste piles that result from mining processes.” These residual materials, often comprising a mixture of water, chemicals, and crushed rock, pose significant environmental and safety challenges, and companies are looking for new solutions to manage this waste. Historically, tailings have been stored in ponds or dams, but this approach has been met with scrutiny due to environmental risks and the impact on the surrounding ecosystem.

A paradigm shift in tailings management is underway, exemplified by the initiatives of companies like CVW, which is developing a technology “that can recover the last bits of hydrocarbons from oil sands and the minerals which are usually associated with the hydrocarbons in tailings (...) thus reducing fugitive methane emissions whilst also cutting GHG emissions by 5% to 10% per site.” Nigel Robinson, CEO of Central Asia Metals, tells us that his company is “recovering copper from surface waste dumps that originated from the Kounrad open-pit copper mine in Kazakhstan.” The company has produced 15,000 tons per annum of copper, all out of tailings waste left over by the USSR – a reminder that the circular economy can thrive in the most unexpected places and over multiple generations. The wastes from uranium mining, as the reader can probably imagine, can require close monitoring. Denison Mines, a uranium mining development company in Canada is solving this problem prior to its conception. CEO, David Cates, comments that “a critical part of our sustainability story is that the mining method we are using extracts the uranium from the ground without creating conventional tailings, hence avoiding the need to store mine waste on surface. This is new to uranium mining in our region and is of great interest to potentially impacted Indigenous groups, as our activities are not expected to leave a lifelong legacy of tailings in their ancestral lands. Finally, innovator Tera Earth is another young company working ingeniously to reprocess tailings which already exist in order to re-extract metals and clean the surrounding water. Tera’s CEO, Vikramaditya G. Yadav, told us his motivation: “Did you know that 200 million tons of copper is

trapped within tailings around the world, a vast majority of which are in acidic ponds? Imagine if one were to mine these waste sources rather than expending significant resources to store or neutralize them. Their technology is based on microbial fuel cells, and aims to solve this problem: “Addressing the environmental hazard of tailings involves handling a large volume of water (about 200 trillion liters globally), which is stored in approximately 9000 tailings ponds worldwide. Our technology aims to reduce this risk substantially by diminishing the volume of these tailings ponds, therefore presenting a solution that is both environmentally sustainable and economically beneficial by tapping into metal wealth, once discarded as waste.”



Innovation & Opportunity

The global mining industry has exhibited resilience and promise despite difficulty in recent years. The trajectory is upward, driven by the green electrification movement, central bank hedging, and consumer demand for sustainable mining practices. Meanwhile, after decades of under-investment, North America touts new promise. Whether the movement to bolster the Western supply chain comes too late, and will merit enough legislative support, is an open question. Looking to precious metals, gold prices continue to rise, in contrast with decreasing global security. The pandemic, the war in Ukraine, and uncertainty in the Middle East have all been good news for gold. The silver market is undergoing significant diversification, as applications within renewable energy necessitate new demand, and burgeoning prices, after a decade of discounting.

Africa and South America emerge as the pivotal continents, rich in untapped mineral resources, and offering new partnerships to the highest bidder. Amidst the influx of new demand, environmental concerns loom large. The mining industry still grapples with its environmental footprint, and is seeking innovative solutions to reduce water usage, energy consumption, and tailings pollution. This is more the concern for Western miners than their Chinese counterparts, which complicates the economics. The industry is confronted with an imperative: how can Earth's mineral wealth be harnessed without compromising its future? This balance between security and sustainability is the defining challenge in this New Era of Mining.

Leading by Example



ROB MCEWEN | CEO, MCEWEN MINING

Our Los Azules copper project will use less than one quarter of the water, and will emit less than one third of the carbon of an average mine. By 2038, we will be net zero and utilize an electric mobile fleet, powered by 100% renewable energy.



TYCHO MÖNCKS | MANAGING DIRECTOR, BCG

AI has the potential to transition mining from a supply-driven to a demand-driven business, assisting companies to make informed decisions on market demands and adjust their strategies accordingly.



DAVID TAIT | CEO, WORLD GOLD COUNCIL

Digitalizing gold can remove barriers for institutional investors. It would amount to a completely regulated and transparent market, where all the risk factors drift away.



MITCH KREBS | CEO, COEUR MINING

Silver is a phenomenal material, and it plays an underappreciated role as a technology metal. Electrification is a dominant trend worldwide, driving the need for silver. Being situated in the US offers a strategic advantage.



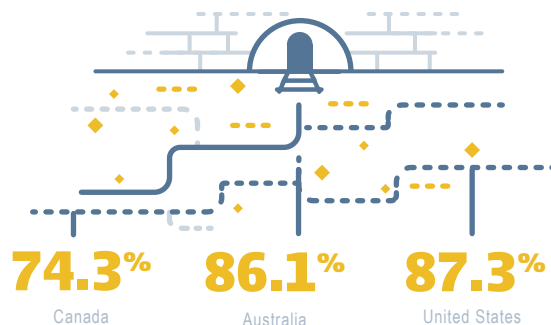
RICH NOLAN | PRESIDENT & CEO OF THE NATIONAL MINING ASSOCIATION

We are actively reaching out to the next generation of miners to address some of the misperceptions around the industry, to help articulate how great these jobs are for individuals, local communities, and for the economy as a whole.

MIKKO KETO |
CEO, FLSMIDTH



A portion of our customers are already partially operating their mines remotely. As they start to see more value in this type of mine management, they become increasingly willing to invest in more sophisticated technologies.



Canada, Australia and the U.S. have each significantly increased their mining exploration spend from 2018 to 2022

Source: EY, 2023

