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Objective, incisive editorial for people who are serious about mining

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Exploration and project activity continues apace

Munesu Shoko

As the new year begins, 2021 promises to be another good year for exploration and project construction activity in the African mining sector. Despite the challenges associated with the ongoing COVID-19 pandemic, mining firms continued with their exploration and project construction activities across Africa in 2020, with some reaching key milestones during the year.

The mining industry is not sustainable without investment in exploration. The discovery of new assets is not only critical for sustaining current output levels or growing the industry, but also crucial if African countries are to diversify their mining industry and remain competitive globally.

Gold and critical metals seem to be the metals of choice for investors at the moment in terms of exploration investment. We have recently seen several junior miners seeking to diversify their project portfolios with maiden investments in gold. As you will see in this edition of *Modern Mining*, companies and investors the world over have been keen to increase exposure to gold.

To provide context, Kodal Minerals, the mineral exploration and development company focused on its Bougouni Lithium Project in Mali, in December last year acquired the Fatou Gold Project in southern Mali, an advanced asset with historic resources of 350 000 ounces (oz) that are expected to grow significantly subject to an upcoming funded and comprehensive nine-month drilling programme.

Elsewhere, Contango Holdings, the London listed natural resource development company, which is currently developing its Lubu Coking Coal Project in Zimbabwe, announced the acquisition of the Garalo Gold Project in Mali for US$1-million. Garalo is an interesting project, following the news that the potential resource is 460% larger than previously estimated due to reinterpretation of historic data. The potential resource at Garalo could now exceed 1,8-million oz, which would certainly put Contango on the map.

Following its listing on the London Stock Exchange late last year, Critical Metals Plc, a mining investment company established to target opportunities in the overlooked and under-analysed mining sector, announced that it had put wheels in motion to start acquisitions in the critical and strategic metals sector in Africa. The company maintains that its interest in critical metals is driven by the fact that supply/demand fundaments are forecasted to continue to improve as critical raw metals play an increasingly important role in global economic and technological development.

Pensana Rare Earths Plc also recently reported high grade rare earths in soils from the first sampling programmes completed at its 7 500 km^2 Coola Project located 16 km north of its flagship Longonjo project in Angola. The high grade rare earth assays are a great start for the company, from what is only the first of several exploration targets for critical technology metals identified within the new Coola project.

From a project development perspective, we have in this issue highlighted some of the projects currently setting the pace in the African mining sector, and these include AfriTin's Uis Tin Mine in Namibia, Perseus Mining's Yaouré Gold Mine and Newfield Resources Limited's Tongo mine in eastern Sierra Leone.

The Uis Tin Mine for me is proving to be the jewel in the African tin mining landscape. In the face of challenging operational conditions posed by the COVID-19 pandemic, the project defied the odds to achieve nameplate tin concentrate production of 63,9 tonnes before the end of 2020. The milestone speaks volumes of the capabilities of the AfriTin Mining Limited team and the high quality nature of the asset.

Elsewhere, Perseus Mining Limited successfully completed the first pour of gold at its Yaouré Gold Mine in Côte d'Ivoire in December. The milestone was achieved nearly five weeks ahead of schedule, consistent with the company's stretch target of first gold at Yaouré in December 2020. The total construction cost, including measures to combat the COVID-19 pandemic, was projected in November 2020 to be below the budget of US$265-million and, by the end of December 2020, a total of US$237-million had been paid to suppliers of goods and services. The company remains confident that the final cost will come in below the budgeted cost of US$265-million, once all accounts have been settled.

Another interesting project for me is Newfield's Tongo mine, which yielded its first production diamonds in December 2020. As far as development is concerned, the underground decline development at the project has exceeded 550 m and first kimberlite was intersected in December last year, which yielded the first carats from the mine. 2021 will see further development to establish mining faces prior to a ramp up in production carats in 2022.

In conclusion, there should be a more favourable environment in 2021 for miners and metal producers as most mineral and metal prices are expected to average higher prices on a year-on-year basis. There are, therefore, good reasons for miners and those who invest in mining to be optimistic going into 2021 as most leading indicators point to a rebound, and long-term drivers for capital spending remain intact. ■

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Expected growth for natural graphite production in 2021

After increasing in 2018 and 2019, global natural graphite production was adversely affected by COVID-19 in 2020, with mines being placed either under care and maintenance or temporary suspension due to lockdowns and restrictions. While output declined by 15,4% to 952,6 kt in 2020, it is expected that natural graphite production will increase by 7,6% in 2021 to 1 025,5 kt and grow to 1 206,6 kt by 2024 at a 5,6% CAGR, according to GlobalData, a data and analytics company.

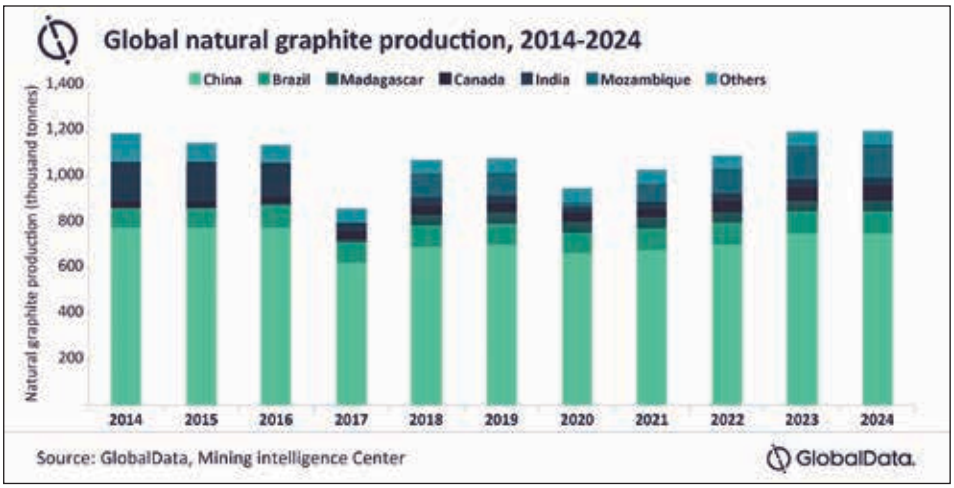
China is the world's largest producer, with expected output of 665 kt of natural graphite. This represents a decline of 5% versus 2019 due to COVID-19 restrictions, mainly during the first quarter of 2020 when several mines and plants had to temporarily cease production activities.

Vinneth Bajaj, senior mining analyst at GloblaData, comments: "While it was the second-largest producer in 2019, Mozambique's graphite output is expected to fall from 100 kt to 20 kt, placing the country sixth overall out of world production. The reduction is due to the Balama Graphite project, operated by Australia's Syrah Resources, being suspended due to restrictions and lower EV demand, with no production at all since April 2020. The project is well positioned to commence operations once the market conditions improve."

Similarly, production from Brazil is expected to decline by 4,1% due to lockdowns and restrictions, which became prevalent during the second and third quarters of 2020.

Bajaj continues: "Natural graphite production is expected to reach 1 206,6 kt by 2024 – a 5,6% CAGR. This will be supported by growing demand from the electric vehicle battery segment, where graphite is a key component. As well as the restart of the Balama Graphite project, projects most likely to commence operations during the forecast period include Madagascar's Molo graphite project (2021), Mozambique's Montepuez and Tanzania's Lindi Jumbo (2022).

"These projects, together with the development of Syrah Resources' Vidalia Battery Anode Material Project, which will make it the first vertically-integrated producer of natural graphite active anode material outside China, will assist in reducing China's dominance in the sector and providing alternative sources for battery makers across the globe." ■



Natural graphite production is expected to increase by 7,6% in 2021.

BlueRock Diamonds' expansion project nearing completion

BlueRock Diamonds PLC, the AIM listed diamond producer, which owns and operates the Kareevlei Diamond Mine in the Kimberley region of South Africa, announces that its expansion project at the mine is nearing completion.

During the course of the expansion project at Kareevlei, the BlueRock management team decided to upgrade certain elements of the plant to ensure optimum production levels going forward.

At the time of writing, the crushing circuit was set to be completed by the end of 2020 and was due to be commissioned in early January 2021. The rest of the plant is expected to be installed in phases during Q1 2021 to ensure no disruption to operations.

Guidance for Q1 2021 is to process 130 000 tonnes (t), 75% up on Q1 2020 of 74 000 t. Production guidance of between 850 000 and 1-million t for 2021 remains unchanged.

BlueRock executive chairman, Mike Houston, says: "During the course of the expansion project at Kareevlei the BlueRock management team decided to upgrade certain elements of the plant to ensure optimum production levels going forward. While this has slowed the expansion project down slightly, we are pleased to say that the decision has had no impact on our internal target for output for Q1 2021 and on the earlier production guidance given for the full year of 2021.

The company continues to advance its expansion strategy at Kareevlei, designed to increase the mine's volumes to 1-million tonnes per annum (mtpa) and extend the life of mine. Further work will be undertaken in 2021 to prove the continuation at depth of the KV2 section of the main pit and to establish the true size of KV3, which is expected to increase the resource and the life of mine further. ■

Drilling commences at Haneti Nickel Project

Katoro Gold plc (AIM:KAT), the AIM listed gold and nickel exploration and development company, announces that the maiden drill programme is underway at its Haneti Nickel Project in Tanzania, having successfully mobilised the team and drill rig to site and with the local and regional approvals in place. Katoro holds a 65% interest in Haneti with 35% held by Power Metal Resources plc (LON: POW).

About 2 000 m of rotary air blast (RAB) drilling is planned over 50 holes to circa 40 m depth per hole.

The RAB drill holes will be drilled on profiles across the three target areas in order to provide enhanced information of the subsurface shape and orientation of the ultramafic rock bodies being targeted and allowing for the optimisation of a planned follow-on diamond drill programme. Katoro's costs in respect of the programme are fully covered from existing cash resources.

"We are very excited to see the first exploration drill programme at Haneti now underway and look forward to updating shareholders as the work progresses," says Louis Coetzee, chairman of Katoro Gold.

The Haneti Nickel Project covers an area of approximately 5 000 km^2 in central Tanzania, approximately 88 km north of the capital city Dodoma. It comprises tenements (prospecting licences, offers and applications) prospective for nickel, PGMs and gold.

One of the key exploration objectives for the JV partners at Haneti is to delineate the potential for economic nickel mineralisation on the linear dyke-like, Haneti-Itiso Ultramafic Complex (HIUC), which sporadically crops out over a strike length of 80 km through the centre of the tenement holding. The HIUC mainly comprises serpentinites (metamorphosed ultrabasic rocks such as dunite and peridotite), with metabasic rocks such as metagabbro and metadolerite and is being targeted for a Chonolith-Type Nickel exploration model.

An initial three target areas have been selected for RAB drilling: Milhanza Hill, Mwaka Hill, and Igari Hill. These targets are based on the recommendations of the 2012 AEM survey, the detailed field programme undertaken in 2013, and further supplementary exploration findings.

Louis Coetzee, chairman of Katoro Gold.

The planned 2 000 m RAB drilling programme will consist approximately 50 holes drilled on linear fences across the targets. The programme will seek to verify the existence of near surface nickel sulphide mineralisation at each target whilst increasing the geological understanding such that the orientation and the meterage of a planned follow-up diamond drill programme can be optimised to confirm the scale of any nickel sulphide mineralisation. ■

Further positive drill results at the Sanankoro Gold Project

Cora Gold Limited, the West African focused gold company, has announced further drill results on both the Dako II permit contiguous with its flagship Sanankoro Gold Project and the Tagan permit adjacent to the north of the Hummingbird Resources Plc Yanfolila Mine, in southern Mali. The Dako II drilling, which lies immediately to the south of Sanankoro, builds on the discovery made there last year. The Tagan drilling is the follow-up of a small rotary air blast (RAB) programme drilled June 2019.

Bert Monro, CEO of Cora Gold, comments: "We are delighted to have followed up last year's discovery at Dako II with further promising results. Seeing the footprint of the Dako II continuing to grow is exciting and having over +3 km of surface mineralisation still to be drilled offers the potential for even more. Dako II is 7 km south of our resources at Sanankoro and we would hope to see this discovery turn into part of the future resources and mine plan for the project."

Cora Gold completed a 1 264 m (18 drill holes) shallow AC drilling programme on the Dako II permit, with the objective of discovering a new, near surface, oxide gold zone that could lie within easy haulage distance of the Sanankoro Gold Project.

The primary lithologies observed at Dako II in drilled holes were mostly siltstone and sandstone. The majority of the upper oxide portions of the holes were completely altered to kaolinite and clays. Visible gold was successfully logged across all of the Dako II holes and 3D modelling allowed better targeting of later holes after DC0029. The Q4 2020 Dako II drill programme was designed to follow-up on the previous phases of exploration drilling targeting the regional Fie Shear Zone on drill sections sited between 100 m and 600 m apart.

The drill results have defined a broad zone of economic grade oxide mineralisation which is 120 m wide and extends over 2 km as currently tested. ■

Graham Clarke appointed Emmerson Plc director

Emmerson Plc, the Moroccan focused potash development company, has appointed its CEO Graham Clarke as a director of the company, effective 22 December 2020.

Clarke is a highly experienced fertiliser industry executive with 26 years' experience in underground potash mining. His broad experience includes managing all technical disciplines, due diligence processes and stakeholder engagement.

Mark Connelly, chairman of Emmerson, comments: "Graham has done a great job during his first five months as CEO and we are delighted he has now joined the board. As work continues to progress on schedule at the Khemisset Potash Project, the company is entering an important time in its development and Graham's industry expertise will be invaluable in supporting our continued progress. We look forward to an exciting year ahead in 2021 as Emmerson enters its next stage of development." ■

Karowe receives mining licence renewal and extension to 2046

Lucara Diamond Corp and Lucara Botswana (both Lucara respectively) have announced that the application for the renewal of mining licence No 2008/6L in respect of its AK06 (Karowe) Mine has been approved by Botswana's Minister of Mineral Resources, Green Technology and Energy Security. The renewal is effective January 4, 2021 for a period of 25 years, securing Lucara's mining rights to 2046 and marks a critical step in the formal sanction of the Karowe underground expansion project.

Eira Thomas, President and CEO, comments: "The receipt of our mining licence renewal and extension to 2046 is an important milestone for the Karowe underground expansion project, paving the way for the completion of a supplemental debt financing and full project sanction later this year. Lucara is grateful for the confidence and support demonstrated by the Government of Botswana as we work to expand our operations at Karowe underground, for the benefit of the government and the people of Botswana together with Lucara's shareholders. We look forward to continued cooperation and a mutually rewarding partnership with the Government of Botswana."

The Karowe underground expansion project, which continued to advance in 2020 under a revised US$22-million budget in response to COVID-19, focused on time critical-path items, detailed engineering and design, and limited earth works and geotechnical studies. The company continues to explore debt financing options for the underground expansion for those amounts which are expected to exceed the company's cash flow from operations during the construction period. The underground expansion programme has an estimated capital cost of US$514-million and a five-year period of development, with first ore anticipated from underground in 2026. ■

The mining licence renewal for Karowe is effective January 4, 2021 for a period of 25 years.

Barrick achieves 2020 production targets

Barrick Gold Corporation (NYSE:GOLD) (TSX:ABX) has announced preliminary full year and fourth quarter 2020 results which indicate that it has met its 2020 guidance targets. Preliminary gold production for the full year of 4,8-million ounces is at the midpoint of the 4,6 to 5-million ounce guidance range, while preliminary copper production of 457-million pounds is also within the guidance range of 440 to 500-million pounds.

The preliminary Q4 results show sales for the quarter of 1,19-million ounces of gold and 108-million pounds of copper, as well as preliminary Q4 production of 1,21-million ounces of gold and 119-million pounds of copper. The average market price for gold in Q4 was US$1,874 per ounce, while the average market price for copper was US$3,25 per pound.

Preliminary Q4 gold production was higher than Q3 2020, mainly due to a strong performance from Pueblo Viejo, the ramp-up of mining operations at Bulyanhulu and ongoing improvement at Turquoise Ridge. Preliminary Q4 gold sales were lower than Q3 2020 as third quarter sales included the export of the remaining stockpiled concentrate in Tanzania. Q4 gold cost of sales per ounce1 and total cash costs per ounce are expected to be in line with the prior quarter and gold all-in sustaining costs per ounce are expected to be 3 – 5% lower than in Q3 2020.

Preliminary Q4 copper production was higher than Q3 2020 following completion of plant maintenance at Lumwana in the third quarter. Preliminary Q4 copper sales were lower than the previous quarter, primarily due to the timing of shipments at Lumwana. Q4 copper cost of sales per pound1 is expected to be 4 – 6% higher, Q4 copper C1 cash costs per pound2 are expected to be 10-12% higher and copper all-in sustaining costs per pound2 are expected to be 4 – 6% higher than Q3 2020. Driving these changes are higher operating costs at Lumwana and Zaldívar, partially offset by lower depreciation and lower sustaining capital at Lumwana. ■

Resolute Mining to sell interest in Bibiani Gold Mine

Resolute Mining has agreed to sell its interest in the Bibiani Gold Mine, through the sale of shares in Mensin Bibiani Pty Ltd, to Chijin International (HK) Limited, a wholly owned subsidiary of Chifeng, for total cash consideration of US$105-million.

Resolute and Chifeng are committed to ensuring an orderly transition of ownership at Bibiani. Chifeng is committed to injecting the necessary capital to achieve the rapid restart of Bibiani to ensure that all local and national stakeholders benefit from the economic and social advantages that the successful operation of the mine will provide.

The transaction is not expected to result in any immediate changes to employment or contract relationships at Bibiani with Chifeng seeking to retain all existing local employees in future activities.

Resolute's interim CEO, Stuart Gale, comments: "Resolute is proud of its contribution to Ghana and pleased that our investments at Bibiani in exploration, feasibility studies, and community support will provide a strong base for future success and value creation. I am confident that Resolute's positive legacy in Ghana, and the interests of all stakeholders in Bibiani, will be protected and enhanced under Chifeng's ownership."

"The transaction is consistent with our strategic focus on our core operating assets together with balance sheet improvement."

Chifeng's executive chairman, Wang Jianhua, comments: "We are delighted to have secured such a significant gold mining asset in the current market. Resolute has defined an exciting future for Bibiani as a high margin, long life underground gold mining operation. Chifeng will immediately invest the required capital, and provide the necessary expertise, to recommission Bibiani as an operating gold mine in the shortest possible timeframe." ■

High grade rare earths confirmed at Pensana's Coola project

Pensana Rare Earths Plc (LSE: PRE, ASX: PM8) reports high grade rare earths in soils from the first sampling programmes completed at its 7 500 km^2 Coola project located 16 km north of its flagship Longonjo project in Angola. Also reported is the appointment of accomplished economic geologist Grant Haywood as exploration manager together with an update on recent site activities at the Longonjo. Assay results received from soil sampling over the Coola carbonatite identify a high tenor soil anomaly up to 4,69% REO extending over a 1,3 x 1,4 km area.

The highest REO values lie over the 3,2 km perimeter of the carbonatite ring structure and are coincident with an outcropping circular carbonatite dyke. The centre of the 1,2 km diameter ring structure is anomalous in REO in soils despite lying beneath thick soil cover, which could partially mask a soil response.

An area of outcropping fluorspar mineralisation located 300 m south of the ring structure is also associated with anomalous soils to 2% REO. The company plans to drill test these defined targets in 2021. ■

Robert Hull, senior director – Business Development Mining, Minerals & Metals EMEA at Worley.

Leading the way towards a

The past 10 months have seen Worley adapt, transform and develop as the global provider of professional services emerges from the eye of the COVID-19 storm more strategically optimised than ever before. With clear answers to cleaner energy choices and advanced front-end digital solutions, Worley is leading the way towards a more sustainable world.

Challenges such as climate change, the energy transition and digitalisation are altering the way industries operate, and as businesses around the globe restrategise, Worley's sustainable solutions are rapidly gaining traction. With the technology to answer pressing questions, such as how to produce more energy while lowering carbon emissions, Worley is well equipped to help the mining sector navigate towards a greener streamlined future.

Robert Hull, the recently appointed senior director – Business Development Mining, Minerals & Metals (MM&M) EMEA at Worley, sheds some light on developments in southern Africa's mining industry and discusses how sustainability is at the core of every project Worley undertakes.

He says it's back to business for mining as Worley continues to offer traditional engineering and infrastructure solutions complemented by cutting-edge technological innovations that contribute to environmentally responsible and sustainable project outcomes.

Hull, together with Business Sector Manager for MM&M Gladwin Mfolo, and Southern & East Africa Operations Director Sean Kellman, forms part of the trio at the core of the new MM&M operation team for Africa.

Bringing new energy solutions into the mix

"Worley's MM&M operation is helping to improve mine and plant efficiency by developing solutions that lower energy and water consumption and reduce emissions. We are working with our customers to introduce best practices and new technology, while our digital and new energy

Worley continues to offer traditional engineering and infrastructure solutions to the mining sector.

more sustainable mining sector

capabilities allow us to help existing and new mines lower the environmental impact of their extraction and processing operations," says Hull.

With experience in delivering projects across the globe, Worley can easily tap into its breadth and depth of expertise to tackle complex challenges in the southern African mining sector, as well as the rest of the world. The impact Worley's work has on the environment is controlled through its Sustainable Solutions process, and this can be put to action on a project in any stage and regardless of its size.

"For example, as the complexities of bringing renewable energy onto existing distribution networks increases, our customers require more agile, resilient solutions. Worley can provide this through our Distributed Energy Systems (DES). We have already delivered over 2 000 new energy projects locally and globally and are recognised as a leading player in the transition to distributed energy systems," says Hull.

These solutions are designed to optimise complicated, multi-streamed energy systems easily and cost effectively. Worley also offers a revolutionary way of dealing with a traditionally fragmented power industry through VECKTA, a digital marketplace where people and companies who want a DES can design, choose the technology, locate someone who can build, and finance the project.

On-site advantages of DES include a reduction in energy costs, improved safety and business uptime, and reduced emissions, while ancillary benefits for the surrounding grid include voltage and frequency

As the complexities of bringing renewable energy onto existing distribution networks increases, Worley can provide agile, resilient solutions through its Distributed Energy Systems.

Worley's MM&M operation is globally recognised for its deep-level shaft experience.

Worley is still very much focusing on its traditional EPCM (engineering, procurement and construction management) services.

support, black start support, and overall improved power quality and reliability.

EPCM still a mainstay

Hull adds that Worley is still very much focusing on its traditional EPCM (engineering, procurement and construction management) services and is able to offer customers forward-thinking, cost-saving benefits through smart technology and digitalisation.

He refers to the De Beers Venetia Mine in Limpopo, the biggest source of rough diamonds in the country, where Worley is the appointed EPCM contractor and is currently in the process of transitioning the mine from open pit to underground. This will extend the mine's life by about 25 years. Worley's scope of work includes all underground and surface infrastructure.

The business's MM&M operation in South Africa is globally recognised for its deep-level shaft experience, and Hull says some of its key achievements to date include complete design, construction management and commissioning of the surface earthworks, shaft bank terrace, collar, service and production headgears, electrical supply substations and both winder buildings.

Going digital for greater insights

The organisation's capabilities, however, go far beyond the third dimension and up to 7D which entails delivering a digital replica of a facility ready for commissioning. Worley is one of the few companies globally with these in-house digital capabilities.

Following on 3D, the inclusion of 4D comes with the benefit of providing a project schedule and greater insight throughout the design process, while 5D adds cost and budget elements. 6D introduces SEAL (sustainable engineering for asset life cycle) integrating technical integrity and safe, sustainable design processes. The final 7D model is a digital replica offering a virtual environment that helps customers witness how a project will evolve.

Worley gathers, classes and organises this data by using building information modelling (BIM) principles which collects vast sources of information on a relational database on a project, and graphically presents virtual business models and solutions based on this data. BIM, therefore, allows an entire project's design and cost stages, as well as construction, operational and maintenance management, to be updated with the most current information in real-time.

"Our BIM capabilities give our clients the opportunity to make timely decisions and improvements at any stage of a project's lifespan, offering front-end solutions that quickly show what can be achieved," says Hull.

Southern & East Africa Operations Director for Worley, Sean Kellman, confirms that Worley's customers are increasingly realising the cost-saving benefits of digitalisation and smart technology, and this is putting a different spin on the mining arena. "Mining is far from dead, but it is changing its operational outlook with a massive move, both locally and globally, towards cleaner, smarter, more reliable energy sources," he comments.

He adds that although Worley's own internal evolution was accelerated by the COVID-19 pandemic, it was far from unplanned, with Worley always aiming to be part of a world where business, communities and ecosystems all thrive together. "COVID-19 pushed our optimisation plans forward by about six months, and we began our transformation in July last year. Diversity and inclusion were major driving factors in this regard, as well as delivering a more sustainable world for future generations." ■

Key takeaways

- Challenges such as climate change, the energy transition and digitalisation are altering the way industries operate, and as businesses around the globe restrategise, Worley's sustainable solutions are rapidly gaining traction
- Worley's Mining, Minerals & Metals operation is helping to improve mine and plant efficiency by developing solutions that lower energy and water consumption and reduce emissions
- With experience in delivering projects across the globe, Worley can easily tap into its breadth and depth of expertise to tackle complex challenges in the southern African mining sector, as well as the rest of the world
- Worley is also still very much focused on its traditional EPCM (engineering, procurement and construction management) services and is able to offer customers forward-thinking, cost-saving benefits through smart technology and digitalisation

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Unpacking Africa's top mining projects

In this year's Top Mining Projects feature, we have selected projects distinguished by their size, high quality nature of the assets and innovation by the teams on the ground. This year we have selected three that have set the bar high from three different African countries, covering tin, gold and diamonds.

The first project of note is **AfriTin Mining Limited's Uis Tin Mine** is Namibia. Despite the COVID-19 influenced operational challenges, nameplate tin concentrate production and completion of production ramp-up for Stage I of Phase 1 were successfully achieved during November 2020. The company achieved 63,9 tonnes of tin concentrate (containing 41,6 tonnes of tin metal) during the month of November, a 32% improvement on the previous month.

The production level achieved in November 2020 represents approximately 107% of the Stage I target in terms of tin concentrate tonnes produced and 116% of the Stage I target in terms of tin contained in concentrate.

The Uis Tin Mine project involves the redevelopment of the historic Uis hard rock mine. AfriTin is developing the project in two phases, with Phase 1 involving an estimated capital expenditure of £7-million on a processing plant capable of producing 60 tonnes of tin concentrate per month. The Phase 1 processing plant commenced partial operations in August 2019.

The second 'Top Project' is **Newfield Resources Limited's Tongo Diamond Mine** in eastern Sierra Leone where first kimberlite was intersected in December 2020, yielding the first production diamonds. The occasion is the culmination of the investment in the Tongo project by Newfield since its acquisition of Stellar Diamonds in early 2018.

Apart from the 550 m underground development and the first production diamonds, Newfield has achieved several key project milestones since taking control of the project. The first major milestone was the declaration of the 7,4-million carat diamond resource, of which 1,1-million carats has been declared as a probable reserve.

Another major milestone has been the completion of the FEED study, which was commissioned by Newfield following its acquisition of Stellar Diamonds in early 2018. The FEED study was completed by leading mining consultant, Paradigm Project Management (PPM) in April 2019 and delineated a technically robust and highly economic project.

Currently, the focus is on advancing the decline towards the Kundu kimberlite, which has advanced some 114 m to a split in the drive to an incline to the top of the ore reserve and RAW, and the continuation of the decline to access deeper levels of the Kundu ore reserve where mining stopes will be established.

Our third and final Top Project is **Perseus Mining's US$265-million Yaouré Gold Mine** in Côte d'Ivoire, which successfully poured its first gold in December, five weeks ahead of schedule. The company attributes this achievement to a combination of good planning, efficient execution and strong commitment to delivering on promises.

The total construction cost for Yaouré, including measures to combat the COVID-19 pandemic, was projected in November 2020 to be below the budget of US$265-million and, by the end of December 2020, a total of US$237-million had been paid to suppliers of goods and services. Perseus is confident that the final cost will come in below the budgeted cost of US$265-million, once all accounts have been settled.

With the successful development and commissioning of Yaouré, Perseus Mining will own and operate three active gold mines in the West African region, paving the way for the company to achieve its goal of producing some 500 000 ounces of gold per year, at a cash margin of in excess of US$400 per ounce in FY2022. ■

Uis Tin Mine – a jewel in the African

In the face of challenging operational conditions posed by the COVID-19 pandemic, Namibian-based Uis Tin Mine, in line with its projections, defied the odds to achieve nameplate tin concentrate production of 63,9 tonnes before the end of 2020. The milestone, CEO Anthony Viljoen tells Modern Mining, speaks volumes of the capabilities of the AfriTin Mining Limited team and the high quality nature of the asset. By *Munesu Shoko*.

Anthony Viljoen, CEO of AfriTin Mining Limited.

Despite the COVID-19 influenced operational challenges, AfriTin Mining Limited (AIM: ATM), a tin mining company with a portfolio of assets in Namibia and South Africa, achieved its targeted production milestone at its flagship asset, the Uis Tin Mine in Namibia, at the end of 2020.

CEO Anthony Viljoen confirms that nameplate tin concentrate production and completion of production ramp-up for Stage I of Phase 1 were successfully achieved during November 2020. "We are pleased to report that we have successfully completed Stage I of our Phase 1 production ramp-up of our pilot mining and processing facility, achieving 63,9 tonnes (t) of tin concentrate (containing 41,6 t of tin metal) during the month of November, a 32% improvement on the previous month," he says.

The production level achieved in November 2020 represents approximately 107% of the Stage I target in terms of tin concentrate tonnes produced and 116% of the Stage I target in terms of tin contained in concentrate. At the time of writing, the tin concentrate production for the year to November 2020 had totalled 301 t.

Commenting on the key to achieving the milestone, Viljoen tells *Modern Mining* that when AfriTin was floated, the company assembled a world class team of engineers capable of delivering the Uis project. It is a credit to their hard work, he says, that the company has now achieved the milestone. Overall, AfriTin has also found the ore body much easier to work with than expected, allowing for simpler extraction of tin.

The Phase 1 pilot processing plant is capable of processing 500 000 t of ore a year to produce 60 t of tin concentrate a month.

tin mining landscape

AfriTin will now focus on maintaining steady state production, while exploring opportunities for further optimisation and expansion of the operation.

Another key has been the mine's location in Namibia, he adds. The site lies approximately 2 km away from the Uis town and 330 km from Namibia's capital, Windhoek. As a friendly and experienced mining jurisdiction, with a highly skilled workforce, the community's support has enabled the rapid deployment of key updates to the project's processing system.

"We are delighted to have achieved nameplate tin concentrate production of 63,9 t, at our flagship asset, the Uis Tin Mine, ahead of year end. This is a defining milestone that has been achieved by the company. The success speaks volumes of the high quality nature of the asset and the calibre of our management team, whom I would like to sincerely congratulate given the macro challenges faced as a result of the global pandemic," says Viljoen.

"Furthermore, the accomplishment provides us with the platform to progress, with proven confidence, our development plan for the Uis Tin Mine towards a large-scale mining and processing facility."

Optimisation initiatives

The Uis Tin Mine project involves the redevelopment of the historic Uis hard rock mine. AfriTin is developing the project in two phases, with Phase 1 involving an estimated capital expenditure of £7-million on a processing plant capable of producing 60 t of tin concentrate per month.

The Phase 1 processing plant commenced partial operations in August 2019. Following the initial production of tin concentrate, processing plant throughput increased by an average 63% month-on-month from 4 300 t achieved in November 2019, to 5 800 t in December 2019, and to 11 400 t in January 2020.

The ramp-up programme continued to progress well throughout the year, leading to nameplate capacity by November 2020. Central to exceeding nameplate production and reaching this milestone prior to the end of 2020 as previously projected was the implementation of optimisation initiatives during the year.

According to Viljoen, Uis has a huge resource and the most important part is optimising throughput and

Tin concentrate production for the year to November 2020 totalled 301 t.

The company is conducting test work to investigate the feasibility of magnetically separating tantalum minerals from the tin concentrate.

recoveries in the processing plant. The particle size distribution of the plant feed proved to be finer than initial design parameters derived from test work. This resulted in a bottleneck in the fines dewatering section of the plant which was addressed through increasing the capacity of the slimes and grits dewatering circuits.

Debottlenecking of the processing plant focused on the dewatering of the grits tailings (less than 630 microns), dewatering of the slimes tailings (less than 45 microns) and expanding the feed capacity to the spiral plant.

"To counter high wear rates due to the abrasiveness of the ore material we had to look at abrasion resistant materials, optimisation of flow lines and enhanced maintenance planning. Other initiatives included improved process control and retraining of operators," says Viljoen.

Looking ahead, AfriTin will now focus on maintaining steady state production, while exploring opportunities for further optimisation and expansion of the operation. These opportunities include a modular expansion of the plant throughput, and potential production of a by-product in the form of a tantalum concentrate.

"The work ahead to remodel areas of the plant will focus on optimising throughputs and recoveries. Given the modular design of the plant we can increase these throughputs and recoveries incrementally. Due to the size of the ore body, and the gravity-based nature of the plant, economies of scale come into play as we will become more economical the more concentrate we produce," explains Viljoen.

The company is conducting test work to investigate the feasibility of separating the more magnetically susceptible tantalum minerals from the tin concentrate. "We are encouraged by early test work results which indicate the potential of simple

Monthly performance of the Uis Phase 1 pilot plant during 2020

Description	Units	2020										
		Jan	Feb	Mar	Apr *	May	Jun	Jul	Aug	Sep	Oct	Nov
Plant Availability	%	59%	60%	64%	59%	65%	69%	73%	72%	74%	81%	83%
Plant Utilisation	%	58%	66%	68%	54%	70%	76%	88%	81%	85%	85%	87%
Plant Processing Rate	tph	45	51	52	41	48	49	65	70	69	73	74
Ore Processed	t	11 420	14 043	16 866	9 618	16 217	18 551	31 324	30 872	30 831	36 796	38 211
Tin Concentrate	t	11,4	11	12,3	11,1	11,2	19,7	35,3	37,5	39	48,5	63,9
Tin Contained in Concentrate	t	7,4	7,1	8,4	7,7	7,2	12,6	22,7	25,6	27,5	32,2	41,6

* Operations curtailed due to COVID-19 lockdown regulations

magnetic separation for producing a tantalum by-product from the current tin concentrate stream," adds Viljoen.

Strict COVID-19 protocols

While AfriTin is focused on further optimisation at Uis, the health, safety and well-being of its employees, contractors and the local community are of utmost importance. COVID-19 mitigation measures therefore remain implemented across the company and all necessary steps have been taken to safeguard the workforce. At the time of writing, the company reported that there were still no confirmed cases of COVID-19 at the Uis Tin Mine.

Despite COVID-19 related restcrictions, shipping of tin concentrate via the port of Walvis Bay to the off-take partner in Thailand continues unabated. The first shipment – 6 t of tin concentrate with more than 60% Sn metal contained – was delivered to Thailand Smelting and Refining Company (Thaisarco) in February 2020 in line with the terms of the off-take agreement. Under the off-take agreement concluded with AfriTin in August 2019, Thaisarco agreed to buy tin concentrate from the Uis mine for a period of a year. The agreement also included an option to extend the off-take contract period beyond 12 months.

Commenting on the 2021 outlook, Viljoen believes that the year has strong fundamentals for tin, which are closely following the price trajectory of copper. AfriTin, he says, will continue to increase production to maximise its exposure to these positive economics, as well as to the lithium and tantalum markets. All of this work is aimed at bringing the company's overall AISC into the lowest quartile of producers.

The project

The Uis tin project comprises three mining licence areas, namely ML 134, ML 129 and ML 133. The current project activities are located in the ML 134, covering an area over 197 km^2, while the mining footprint is just 8 km^2.

Tin at the Uis deposit is hosted in pegmatites and the ore bodies are found to be up to 80 m-thick, along 1,6 km strike length. The mine was estimated to hold 71,54-million t of JORC-compliant measured, indicated and inferred resources as of September 2019.

The contained tin is estimated to be 95 539 t, while the contained tantalum and lithium oxide are estimated to be 6 091 t and 450 265 t, respectively.

The Uis tin mine was discovered in 1911, and mining commenced in 1923. The mine was expanded after Imcor Tin, a wholly-owned subsidiary of the Iron and Steel Corporation of South Africa (Iscor), assumed ownership in 1958. It became the world's biggest hard-rock tin mine in 1980.

The mining operations however, ceased due to the fall in tin prices in 1990. AfriTin received environmental clearance for the mine redevelopment in August 2017 and started civil construction works for the Phase 1 development in June 2018. Ore extraction commenced in December 2018, while the construction of the Phase 1 processing plant was completed in July 2019.

Given the modular design of the plant, AfriTin is confident that it can increase throughputs and recoveries incrementally.

AfriTin Namibia holds 85% stake in the project, while the remaining 15% stake is held by The Small Miners of Uis (SMU), an enterprise owned by the Namibian Government.

The conventional open-pit mining method involving blast-load-haul operations is employed for the Uis Tin Mine. Mining is carried out in 10 m-high benches, while loading and hauling are performed using a fleet of excavators and dump trucks.

The Phase 1 processing plant consists of a four-stage crushing circuit and a three-stage concentrating circuit. The concentrating circuit includes dense medium separation (DMS), fine gravity concentration and wet high-intensity magnetic separation (WHIMS) modules for the production of saleable tin and tantalum concentrates.

The Phase 1 pilot processing plant is capable of processing 500 000 t of ore a year to produce 60 t of tin concentrates a month. In Phase 2 expansion, the processing plant is planned to be scaled-up for 3-million t per annum throughput capacity. ■

Key takeaways

- ❑ Despite the COVID-19 influenced operational challenges, AfriTin Mining Limited achieved its targeted production milestone at its flagship asset, the Uis Tin Mine in Namibia, in November 2020
- ❑ The company successfully completed Stage I of its Phase 1 production ramp-up of its pilot mining and processing facility, achieving 63,9 t of tin concentrate (containing 41,6 t of tin metal) during the month of November, a 32% improvement on the previous month
- ❑ Uis has a huge resource and the most important part is optimising throughput and recoveries in the processing plant
- ❑ Debottlenecking of the processing plant focused on the dewatering of the grits tailings (less than 630 microns), dewatering of the slimes tailings (less than 45 microns) and expanding the feed capacity to the spiral plant

First production carats from Newfield's Tongo mine

As development continues apace at Newfield Resources Limited's Tongo mine in eastern Sierra Leone, executive director Karl Smithson tells Modern Mining that first kimberlite was intersected in December 2020, yielding the first production diamonds. The high grades and diamond values are a key factor in the success of the project, writes *Munesu Shoko*.

Selection of first production diamonds from the Tongo Diamond Mine.

ASX-listed Newfield Resources has achieved good progress at its Tongo mine project with key project milestones reached thus far. Executive director Karl Smithson reports that the underground decline development has exceeded 550 m and first kimberlite was intersected in December last year, which yielded the first carats from the mine. 2021 will see further development to establish mining faces prior to a ramp up in production carats in 2022.

The first run of mine (diluted) kimberlite from the Kundu ore reserve has been processed via the recently established 5 tph bulk sampling processing plant. The material hauled from underground is being processed as part of the commissioning process of the plant and has yielded first production diamonds from the mine. The larger processing plant is currently being fabricated and will be ready for commissioning by mid-year.

As mine development continues, the volume of run of mine material from the Return Airway (RAW) will increase and its processing, as well as underground surveying of volumes, will allow a reconciliation of the Kundu kimberlite grade versus the ore reserve grade estimate. Progressive build up in kimberlite tonnes and carat recoveries is expected

Newfield reports that the underground decline development has exceeded 550 m.

The core team for the project has since been recruited.

over the coming months as development continues and more mining faces are opened.

"We are very proud of this achievement of first production diamonds from the Tongo project," says Smithson. "A key observation is that the excellent colour and clarity of these diamonds is consistent with diamonds previously recovered from the bulk sampling exercises of the Kundu and Lando kimberlites that are the target of our current mine development."

The occasion is the culmination of the investment in the Tongo project by Ne wfield since its acquisition of Stellar Diamonds in early 2018. "For our team and at a personal level, this achievement represents a career involvement of over 13 years in the discovery, feasibility and development of the Tongo project. While much work lies ahead of us, the first diamonds represent the beginning of an exciting journey ahead for Newfield," adds Smithson.

The project, however, has experienced about six months' delay due to the ongoing COVID-19 pandemic. Travel and supply line restrictions, says Smithson, have slowed the pace of development but the company has managed to continue underground development throughout. "In a mine life of at least 18 years, a six-month delay is not considered to be too fatal," says Smithson.

Project milestones

Apart from the 550 m underground development and the first production diamonds, Newfield has achieved several key project milestones since taking control of the project. The first major milestone was the declaration of the 7,4-million carat diamond resource, of which 1,1-million carats has been declared as a probable reserve.

Leading independent technical consultants, MPH Consulting and Z-Star, completed an updated mineral resource estimate for the Tongo mine in November 2018. The estimate was based on 10 792 m of detailed mine development drilling undertaken in 2018 and updated wireframe and geological models based on recent and historical drilling data (75 000 m in total).

The updated resource estimate totalled 7,4-million

Key project milestones

- ❑ Declaration of 7,4-million carat diamond resource (of which 1,1-million carats has been declared as a probable reserve
- ❑ Completion of FEED study
- ❑ Underground mine design and schedule completed
- ❑ 100 tph processing plant design completed, partly procured and manufactured
- ❑ 550 m of underground development
- ❑ First production diamonds yielded
- ❑ Significant surface and underground infrastructure construction completed
- ❑ Establishment of interim processing plant pending larger processing plant construction

Diamonds from NWS's sampling work.

carats of Indicated and Inferred Resources at a +1 mm cut-off. An initial probable ore reserve estimate of 1,1-million carats (+1,18 mm cut-off) was declared for the Kundu and Lando dykes. The estimate was based on material classified as Indicated mineral resources with dilution and mining losses applied. Consideration of all JORC modifying factors supported the declaration of the ore reserve estimate.

Another major milestone has been the completion of the FEED study, which was commissioned by Newfield following its acquisition of Stellar Diamonds in early 2018. The FEED study was completed by leading mining consultant, Paradigm Project Management in April 2019 and delineated a technically robust and highly economic project. The geological block model, incorporating the updated grade and value estimates, were provided to SRK Consulting to run the mine optimisation programme on Datamine.

Another key milestone was the completion of the mine design and schedule, as well as significant surface and underground infrastructure construction. The Tongo Diamond Mine is accessed via a 6 m x 4 m "joint" decline which has been developed and equipped for a distance of 152 m. Thereafter, the joint decline splits into two 4 m x 4 m declines that will be developed to the Kundu and Lando kimberlite ore reserves respectively.

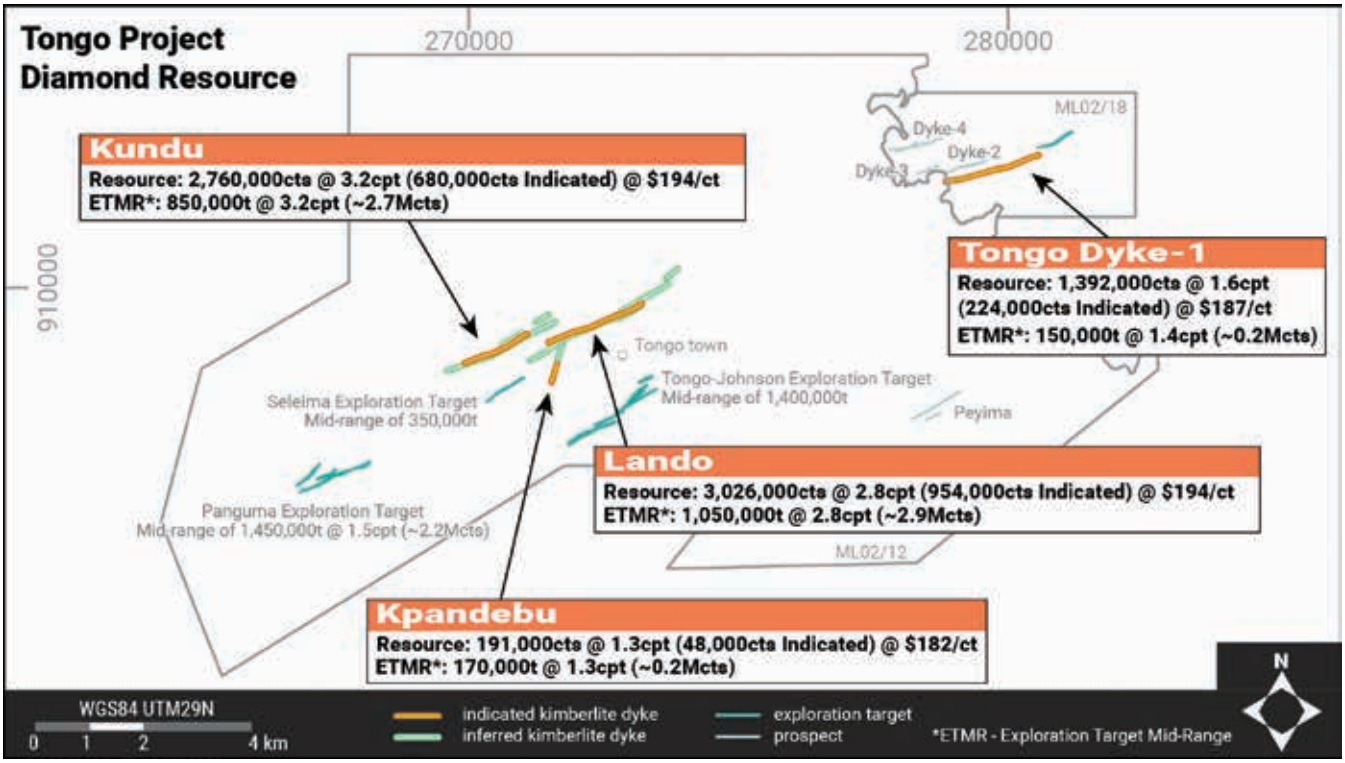
Currently, the focus is on advancing the decline towards the Kundu kimberlite, which has advanced some 114 m to a split in the drive to an incline to the top of the ore reserve and RAW, and the continuation of the decline to access deeper levels of the Kundu ore reserve where mining stopes will be established.

The incline to the RAW has been developed some 125 m before intersecting the Kundu kimberlite at the top of Mining Level 1. The RAW is now being developed with a 4 m x 4 m dimension "on reef" drives to the west along the Kundu kimberlite Segment B which is yielding the first ore from underground. Simultaneously, a drive will be developed towards Kundu Segment A to intersect the kimberlite and progress the drive along its RAW in an eastward direction to a ventilation shaft. The vent shaft will be established to provide the necessary through ventilation for the underground workings, as well as an access route for underground services, and second escape way for workers in the unlikely event of an underground incident.

Looking ahead, Smithson says underground development must continue to go deeper with the declines, and level development must be established to open mine stope faces for production to increase.

Meanwhile, the 100 tonnes per hour (tph) processing plant design has been completed, and has since been partly procured. Newfield initially decided on the relocation and refurbishment of a 50 tph DMS

Tongo project's diamond resource.



processing plant. However, based on the future production profile of the mine, the company later made the decision to install a plant capacity of 100 tph and worked closely with South Africa-based engineering consultants METC in terms of the final design of the plant.

The company has since established an interim processing plant pending the completion of the larger 100 tph plant. "The company is establishing an interim 25 tph processing plant to meet underground production capacity for the next two or so years and this processing plant capacity will be increased as production demands," says Smithson.

The core team for the project has since been recruited, and currently comprises 49 expatriates and 250 national staff.

Once the fissure is intersected it is mined essentially by drilling and blasting overhead and the material drops to the cross cut access from where it is loaded and hauled to surface by 15 t haul trucks.

The project

The Tongo mine development comprises two adjacent mining licences covering 134 km^2 in eastern Sierra Leone. There are 11 known kimberlite dykes within the concession, four of which have declared JORC compliant indicated and inferred diamond resources of 7,4-million carats. The kimberlites are high grade and high value with grades of around 3 carats per tonne and US$200 per carat.

"The very high grades and diamond values are a key factor in the success of this project. With grades of 3 cpt and values of US$200 per carat, we have an in-situ rock value of US$600/t, which is one of the highest worldwide. Optimum production levels are forecast to be over 300 000 carats per year from the current mine, which through further successful exploration can be increased," says Smithson.

Newfield assumed control of the project in 2018 after its takeover of Stellar Diamonds and has since invested over US$30-million on the mine's development. This has included a front end engineering design study (FEED), which was completed in 2019 and demonstrates an 18-year life of mine from three of the four kimberlites in resource. Exploration indicates that the resource could be significantly increased and thus extend the life of mine.

Mining will be exclusively by underground methods with single portal access to Kundu and Lando being provided from the boxcut, which is located approximately midway between the two kimberlites. The selected mining method is traditional shrinkage stoping (with an 85 cm stoping width), a method commonly used in similar kimberlite dyke mining operations in South Africa.

Commenting on why this mining method was chosen, Smithson says kimberlite dykes are by nature narrow, elongate ore bodies. The optimal way to mine these is by underground mining due to too high stripping ratio/costs of surface mining.

"A decline is being sunk to access levels of mining every 35 m of horizontal depth. At each mining level a development drive parallel with the kimberlite strike will be opened with cross cuts into the ore body every 13 m along this drive. Once the fissure is intersected it is mined essentially by drilling and blasting overhead and the material drops to the cross cut access from where it is loaded and hauled to surface by 15 t haul trucks," explains Smithson.

From explorer to producer

On the back of an array of project milestones achieved thus far, Smithson says Newfield is this year transforming from an explorer and developer to a producer. "We will, nevertheless, continue to explore the concession area and are confident of significantly increasing the diamond resource base to extend the current 18-year life of mine and make it a truly generational mine," he says.

Smithson is also encouraged by the business friendliness of Sierra Leone, which he says is a "decent place to do business". There are competitive mining and fiscal laws and no legal requirement for any government or local partner participation. "The diamond quality of Sierra Leone is excellent, with the Tongo goods comprising a very high percentage of top colour white gems," concludes Smithson. ■

Quick take

- Newfield assumed control of the Tongo project in 2018 after its takeover of Stellar Diamonds and has since invested over US$30-million on the mine's development
- First kimberlite was intersected at Tongo Diamond Mine in December 2020, yielding the first production diamonds from the high-grade Kundu ore reserve
- Underground decline development has exceeded 550 m
- Currently, the focus is on advancing the decline towards the Kundu kimberlite, which has advanced some 114 m to a split in the drive to an incline to the top of the ore reserve and RAW

Yaouré Gold Mine pours first gold five weeks ahead of schedule

Perseus Mining Limited has successfully completed the first pour of gold at its Yaouré Gold Mine in Côte d'Ivoire. The company achieved this nearly five weeks ahead of schedule, consistent with its stretch target of first gold at Yaouré in December 2020. *Modern Mining* touched base with the company for an update. By *Mark Botha*.

Perseus Mining MD and CEO Jeff Quartermaine ascribes this achievement to a combination of good planning, efficient execution and "strong commitment to delivering on promises". He says pouring first gold over a month ahead of schedule would not have been possible without strong site leadership and cooperation between Perseus's development team, the various contractors and sub-contractors who worked on the project, and members of the host communities and the Ivorian government.

The total construction cost, including measures to combat the COVID-19 pandemic, was projected in November 2020 to be below the budget of US$265-million and, by the end of December 2020, a total of US$237-million had been paid to suppliers of goods and services.

"We are confident that the final cost will come in below the budgeted cost of US$265-million, once all accounts have been settled," says Quartermaine.

Perseus Mining MD and CEO Jeff Quartermaine.

Perseus Mining acquired Yaouré when it merged with Amara Mining plc in April 2016. The company has since completed an extensive programme of confirmatory drilling and test work, and has prepared

Once fully operational, the mine is expected to process approximately 3,3-million tonnes of ore per year.

The total construction cost, including COVID-19 measures pandemic, is projected to be below the budget of US$265-million.

a definitive feasibility study (DFS). Construction of the mine started in August 2019, after permitting and negotiating a mining convention with the Ivorian government.

Commercial production

With construction of the Yaouré processing plant and associated infrastructure largely complete, Perseus will now focus on satisfying continuous performance tests and positioning to declare commercial production. The company expects to achieve both during the March 2021 quarter, when the first shipment of gold from the mine is expected to occur.

"We originally planned to declare commercial production during the first quarter of 2021," says Quartermaine. "In order to reach this point, we must demonstrate the sustained achievement of key operating parameters, including run time and throughput rates, as well as positive cashflow from operations."

Conservative approach

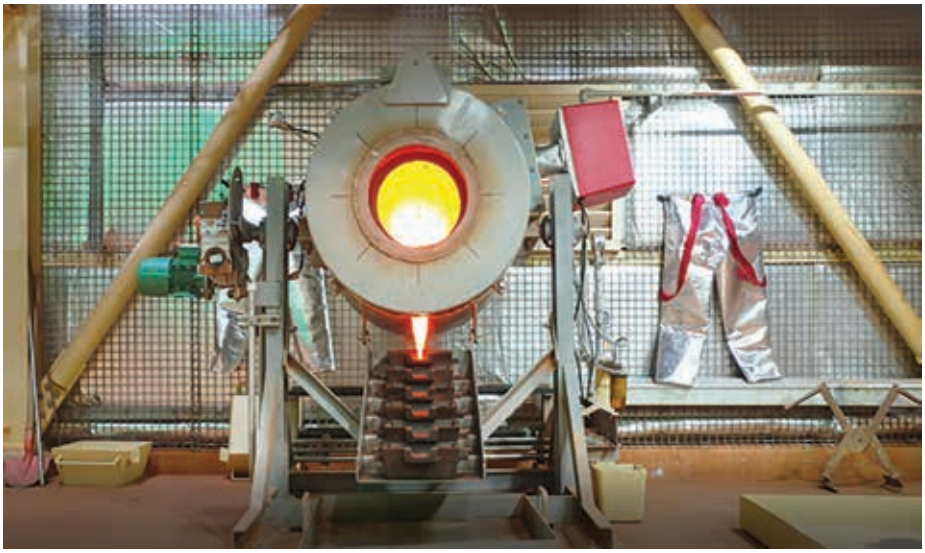
He says that, according to the original schedule, Yaouré Mine would have processed low-grade oxide ores for a period of some six months while access to high-grade fresh ore supplies was being gained.

"However, as a result of better-than-expected performance by our mining contractor, there is a chance that fresh ore will be available for processing sooner than originally anticipated. As a result, we are considering deferring declaration of commercial production until the required technical parameters have been satisfied, while processing both ore types."

Quartermaine says there is merit in this more conservative approach as processing the fresh ore, which is is expected to be harder than the oxide ore, will provide added assurance that the plant is fit for purpose under all operating conditions.

"It is not unusual to commission plants on oxide ore only, especially when access to fresh material is scheduled to occur after oxide ore is available. We applied this approach very successfully at our Sissingue Mine. Given that the availability of fresh ore appears likely to be brought forward, we have the option of taking the more conservative route and will make a decision on this as the March quarter unfolds."

Yaouré, which holds three exploration permits in



Perseus has successfully completed the first pour of gold at its Yaouré Gold Mine.

The first gold pour was achieved nearly five weeks ahead of schedule.

a region covering 360 km^2, is one of three mines belonging to Perseus Mining in the West African region, along with the Sissingué operations, also in Côte d'Ivoire, and the Edikan Mine in Ghana.

Volumes and timeframes

In terms of timeframe before the mine accesses fresh ore from the CMA pit, Quartermaine says the Yaouré DFS did not envisage the processing of high-grade fresh material until July 2021.

"However, with the strong performance by our mining contractor, it is possible for fresh ore to be available for processing as early as May this year, although whether this will be achieved depends on a range of factors including mining and processing plant availability. We will have a better understanding of the timing of events as the March 2021 quarter unfolds, but things are looking promising at this stage."

He says the DFS forecasts annual gold production of around 215 000 ounces at a weighted average all-in-site cost (AISC) of approximately US$750 per ounce over the first five years of the Yaouré mine life. An updated life of mine plan for Yaouré considering the actual commissioning date, current mining rates, operating costs and possible increases in mineral resources, is scheduled for release in the March 2021 quarter.

Ore reserve inventory

"There is a lot to like about Yaouré," says Quartermaine. "The construction has gone well and time and cost targets will be achieved. The operations readiness phase, too, has progressed smoothly, and we were able to recruit a workforce and management team suited to the challenges ahead."

He says early indications from the ramping up of the project are also promising, although proof of concept is only expected in a few months' time.

"What excites me the most, though, is probably the potential to expand the ore reserve inventory and extend the life of the operation through near-mine exploration. The exploration works that have been done to date are encouraging."

A three-dimension seismic survey has been conducted in addition to a range of air core, reverse circulation and diamond drilling programmes.

"The results of the seismic survey were outstanding, and we have recently commenced flying a full-tensor Gradiometry Gravity (FTGG) survey over the Yaouré project area for the purposes of investigating the geology and mineral potential using this technology.

"When all data sets are combined, we should have a good understanding of the true potential of the Yaouré tenements and be in a position to mount targeted, cost-efficient exploration to deliver material growth of the project for many years to come.

With the successful development and commissioning of Yaouré, Perseus Mining will own and operate three active gold mines in the West African region, paving the way for the company to achieve its goal of producing some 500 000 ounces of gold per year, at a cash margin of in excess of US$400 per ounce in FY2022.

"We are confident that the final cost will come in below the budgeted cost of US$265-million, once all accounts have been settled," says Quartermaine.

Perseus will now focus on satisfying continuous performance tests and positioning to declare commercial production. ■

Key takeaways

- ❑ As a result of better-than-expected performance by the mining contractor, there is a chance that fresh ore will be available for processing sooner than anticipated
- ❑ The DFS forecasts annual gold production of around 215 000 ounces at a weighted AISC of approximately US$750 per ounce over the first five years of the Yaouré mine life
- ❑ There is potential to expand the ore reserve inventory and extend the life of the operation through near-mine exploration
- ❑ Perseus Mining will own and operate three active gold mines in West Africa, paving the way for it to achieve its goal of producing some 500 000 ounces of gold per year

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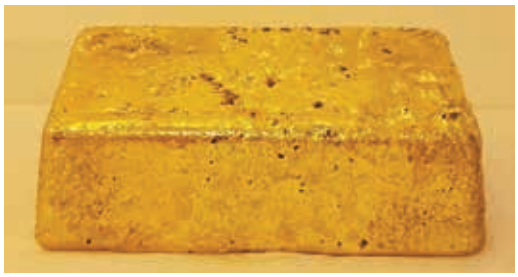
Louise Street, senior market analyst at the World Gold Council.

Gold – safe-haven for investors during COVID-19

The coronavirus pandemic had a significant impact on gold demand in 2020, influencing different sectors of the market in different ways. However, Louise Street, senior market analyst at the World Gold Council, tells *Munesu Shoko* that investor demand for gold strengthened considerably throughout the pandemic, offsetting weakness elsewhere.

That the COVID-19 pandemic had a substantial impact on global gold demand in 2020 is no overstatement. To give an idea, global demand dropped by 19% year-on-year (y-o-y) to 892 t in Q3 2020, as consumers continued to feel the impact of the pandemic. This was the lowest quarterly total since Q3 2009. The year to Q3 2020 demand of 2 972 t was 10% lower compared to the same period in 2019, according to the World Gold Council's Gold Demand Trends report.

"Consumer demand dropped sharply and the jewellery market was hard hit: Q3 demand fell 29% y-o-y to 333 t. During Q3, many countries still had restrictions on people entering public places, such as shopping malls and jewellery shops, coupled with an overall reduction in consumer spending, with some people losing their main sources of income during lockdown. The weakness in demand for jewellery caused by COVID-19 was compounded by record high gold prices. While China and India accounted for the largest volume declines, weakness was global," says Street.



Investment demand saw substantial growth as investors sought gold as a safe-haven.

It was, however, encouraging to see demand in China begin to recover from the weak Q1/Q2 as the market emerged from lockdown and began to return to normal, although demand remained soft compared with 2019.

There has been an increase in gold exploration in recent years, driven by gold miners having healthier balance sheets and the need to ensure an adequate project pipeline to replace aging assets.

Jump in investments

Despite the decline in overall demand, Q3 saw significant growth in investment demand, which rose by 21% y-o-y. "The coronavirus pandemic had a significant impact on gold demand in 2020, influencing different sectors of the market in different ways: consumer demand was considerably weakened by market lockdowns, while investment demand saw substantial growth as investors sought gold as a safe-haven. Holdings of gold-backed exchange-traded funds (ETFs) reached a record level of 3 880 t in Q3," explains Street.

In fact, by any measure, gold-backed ETFs and similar products had a remarkable year in 2020, according to the latest report from the World Gold Council. Globally, gold ETFs had record annual net inflows of US$47,8-billion, or 876 t, collectively increasing their gold holdings by over a third, reaching all-time highs in tonnage (3 751 t).

According to Price, investor demand for gold strengthened considerably throughout the pandemic, as investors focused on gold's role as a risk-hedge and means of wealth protection. Investor demand had already been on the rise prior to

Mine production is expected to improve this year.

outbreak, she says, due to the environment of low or negative real interest rates and geopolitical uncertainty.

"However, the spread of COVID-19 across the globe heightened investors' appetite for gold. Global investment demand for gold (incorporating retail investment in gold coins and small gold bars as well as inflows into gold-backed ETFs) reached 494,6 t in Q3 2020. This was 21% higher than the Q3 2019 total," she says.

"However, investor demand has changed since we last reported these results in our Q3 Gold Demand Trends report. Following months of record inflows for gold-backed ETFs, November marked the first month of outflows in exactly a year. These monthly outflows were the second largest ever, decreasing by US$6,8-billion (2,9% AUM), though net inflows in 2020 (US$50,3-billion) remain well above any previous full-year inflows," she adds.

It is perhaps unsurprising, adds Street, that investors felt more optimistic as news of COVID-19 vaccines dominated the global news agenda. "That said, 2020 has been defined by market volatility and swings in all asset classes," she says.

Judging by the data from the World Gold Council's Q3 Gold Demand Trends report, investors across the three major global regions increased their holdings in gold-backed ETFs. North American-listed funds saw by far the largest share, attracting 70% of the global volume inflow during Q3. Holdings in the region grew by 190,9 t to stand at 2 089,4t (AUM US$126,8-billion) by the end of the quarter.

European-listed fund accounted for 54,9 t, 20% of global additions during the quarter. Meanwhile, Asian-listed gold-backed ETFs saw their highest ever reported quarterly inflows of 20,7 t in Q3, which took holdings in this region to an all-time high of 121 t at the end of September. Funds listed in other regions added 6,1 t during the quarter, with Australia added 5,3 t of the total.

In its latest report, the Wold Gold Council notes that in terms of price performance, gold rose 25% during 2020, hitting a historical high of US$2 067,15/oz on 6 August. Despite dropping 12% in March, when markets were rocked by the onset of the COVID-19 pandemic, gold recovered to finish the year among the best-performing assets, despite many stock indices reaching or surpassing all-time highs.

Gold's volatility during the year was also higher, with annualised volatility at 20%, the highest level since 2013 and significantly above the longer-term average of around 16%. However, the increase in gold's volatility should be viewed in the context of the volatility of all assets. Most assets saw volatility rise last year. For example, the volatility of the S&P 500 climbed to a whopping 32%, almost double its long-term average of 18%.

Exploration in the spotlight

Gold production and exploration data forms an important part of the World Gold Council's market analysis and reports. Street says the council has seen some increases in gold exploration in recent years, driven by gold miners having healthier balance sheets and the need to ensure an adequate project pipeline to replace aging assets.

"There has been a lack of significant new discoveries over the past decade despite gold mining companies investing more in exploration, as this has tended to focus on known deposits or existing operations. While increased M&A activity and weaker gold prices, as well as the impact of the COVID-19 pandemic, have impacted exploration

While there is still uncertainty about how 2021 may evolve, it seems very likely that mines will experience fewer stoppages as the world recovers from the pandemic.

over the past two years, we could see more activity this year," she says.

Meanwhile, in its Gold Outlook 2021 report, the World Gold Council notes that mine production is likely to improve this year. Recovery in mine production is likely this year after the fall seen in 2020, the report says. Production interruptions peaked during the second quarter of last year and have since waned.

While there is still uncertainty about how 2021 may evolve, it seems very likely that mines will experience fewer stoppages as the world recovers from the pandemic. This would remove a headwind that companies experienced in 2020 but that is not commonly part of production drivers. Even if potential second waves impact producing countries, major companies have introduced protocols and procedures that should reduce the impact of stoppages compared to those seen in the early stages of the pandemic.

Key takeaways

- The COVID-19 pandemic had a substantial impact on global gold demand in 2020, with global demand dropping by 19% year-on-year to 892 t in Q3 2020, as consumers continued to feel the impact of the pandemic
- Despite the decline in overall demand, Q3 saw significant growth in investment demand, which rose by 21% y-o-y
- The World Gold Council has seen some increases in gold exploration in recent years, driven by gold miners having healthier balance sheets and the need to ensure an adequate project pipeline to replace aging assets
- Looking ahead, the World Gold Council believes that investors will likely see the low interest rate environment as an opportunity to add risk assets in the hope that economic recovery is on the immediate horizon

2021 outlook

Street expects uncertainty to continue to play a big role in investment behaviour and gold demand all over the world this year. There is ongoing uncertainty as to the longer-term impact of the pandemic on economies throughout the world and what shape the recovery will be, she says. And this will continue to shine a spotlight on gold's role as an effective risk hedge.

"Looking ahead, there are various economic and geopolitical conditions that are likely to be supportive of gold. For example, the higher inflation allowance policy introduced by the US is gaining momentum in multiple regions, assuring that global real rates remain extremely low or negative for the foreseeable future. Our research shows that gold has traditionally performed well in both inflationary and deflationary environments," adds Street.

Looking ahead, the World Gold Council believes that investors will likely see the low interest rate environment as an opportunity to add risk assets in the hope that economic recovery is on the immediate horizon. That said, investors will likely also be navigating potential portfolio risks including ballooning budget deficits, inflationary pressures and market corrections amid already high equity valuations.

"In this context, we believe gold investment will remain well supported while gold consumption should benefit from the nascent economic recovery, especially in emerging markets," concludes Street.

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Mali's golden rewards for adventurous investors

Despite Mali's documented political and terrorist activity struggles, the country has against all odds achieved continuous gold production for more than 30 years, becoming one of the top gold producing nations in Africa. Thanks to the country's rich mining history, companies and investors the world over are keen to increase their exposure to Mali's gold sector, including three London-based junior miners – Kodal Minerals, Contango Holdings and Cora Gold Limited. By *Munesu Shoko*.

As home to a wealth of natural resources and precious metals, and in particular, gold, Africa has always played a significant role in the global mining space. One West African country that has been steadily building its status as a globally significant gold producer over recent decades is Mali.

Mali hosts some of the world's most prestigious miners, including Barrick Gold, Resolute Mining and AngloGold Ashanti, among others, which operate various high grade and sizeable resource assets. Operating on a smaller scale but proving there is plenty of undiscovered opportunity in the gold sphere, Mali is home to operations run by some of the most promising London listed growth companies.

Drilling at Cora Gold's Madina Foulbe permit.

Thanks to the country's rich mining history, companies and investors the world over have been keen to increase exposure to Mali gold – including Kodal Minerals, Contango Holdings and Cora Gold. To provide context, Kodal Minerals in December last year acquired the Fatou Gold Project in southern Mali, an advanced asset with historic resources of 350 000 oz that are expected to grow significantly subject to an upcoming funded and comprehensive nine-month drilling programme.

In October last year, Contango Holdings, the London listed natural resource development company, also announced the acquisition of the Garalo Gold Project in Mali for US$1-million. Garalo is another success story, following the news that the potential resource is 460% larger than previously estimated due to reinterpretation of historic data. The potential resource at Garalo could now exceed 1,8-million oz, which would certainly put the company on the map and firmly in the eye of the aforementioned mining majors operating in the country.

Cora Gold has also made significant progress at its Sanankoro Gold Mine project during the year and agreed a US$21-million term sheet with Lionhead Capital Advisors to fund future development at the project, an extremely strong endorsement of the company from an experienced investment group. Further exploration continues at Sanankoro, with the Cora seeking to unlock more value out of what is regarded as the company's flagship project.

Investment destination of choice

Despite the current political turmoil, military coups, terrorist activity and labour action, Mali remains a destination of choice for London listed junior miners. What makes Mali tick? Bernard Aylward, CEO of Kodal Minerals, says Mali remains a favoured destination for gold investment due to the quality of the gold discoveries, the long life of mines and the ability to move through the exploration discovery

stage to development and mining is a well understood pathway.

"Major gold mining companies such a Barrick, Anglogold Ashanti, IAMGold, B2Gold and Resolute Mining have been operating major gold mines such as Loula, Yatela, Sadiola, Morilla and Syama successfully for many years. The reason Mali ticks is that it has a well-established mining culture that is supported by good mining regulations and access to some of the most prospective ground in West Africa," says Aylward.

Mali is currently the third largest gold producer on the African continent, behind South Africa and Ghana. Continued exploration success and mine development, adds Aylward, has seen Mali's estimated gold reserves exceed 820 tonnes, and it is expected that modern exploration will continue to discover more gold in the country.

Carl Esprey, executive director of Contango Holdings, agrees that Mali remains an investment destination of choice for gold investors, becoming the fastest growing gold producer in the world and the third biggest gold producer in Africa in the process. "It is fair to say that there are multiple multi-million ounce deposits mined by many large international companies like Barrick, IAMGold, Anglogold Ashanti and Resolute, among others, that position Mali as an investment destination of choice for gold investors," says Esprey.

Bert Monro, CEO of Cora Gold, has no doubt that there are a number of reasons for this but for him there are two key ones: "Firstly, it's the geology; Mali has had a number of world class gold discoveries in the past and I am sure it will have more in the future. Secondly, it's the people factor; after 30 years of commercial gold mining in the country, Mali is a mature jurisdiction to build and operate a mine with an excellent local team," says Monro.

Commenting on the risk factor, Monro says Cora's Sanankoro project has not been affected in any way by the current political situation. "We continued to operate the entire period of the transition of power as did others in the country and I have already had the chance to meet the new mining minster in person when I was in Mali before Christmas," says Monro.

According to Esprey, political issues in Mali have been confined to the north of the country. The government, he says, has remained steadfast in promoting the gold industry, and the sector has subsequently been not affected over the past two decades.

The same view is shared by Aylward, who says that Mali has an ongoing situation in the north and far-east of the country, where the Mali military, French support and UN forces have been focusing their efforts to restore stability. Aylward is of the view that the risks of operating in any country should be assessed by each company, and at Kodal they believe their areas of operation in the southern part of Mali, a peaceful, farming region, are secure and there are no security issues to worry about.

Drilling at Sanankoro in April 2020.

"In terms of political risk, I think it is clear that the mining industry has continued through recent

Contango's Garalo permit occupies 62,5 km^2 in the Sikasso region of southern Mali, 200 km south-east of the capital Bamako and close to the Guinea border.

Potential resource at Garalo could now exceed 1,8-million oz.

political changes and that no projects have been affected by the government change," adds Aylward.

Great prospects at Fatou

Aylward is excited about the prospects at the Fatou Gold Project recently acquired by Kodal Minerals. Historic exploration has identified gold mineralisation occurring as free gold in multi-stage quartz and quartz-carbonate ± sulfide veins. Sulfides associated with gold include pyrite, pyrrhotite, arsenopyrite and possible bismuthinite. Gold-bearing veins are mostly subvertical in orientation striking north-south to north-westerly and appear to occur in clusters and local envelopes.

An initial Mineral Resource estimate was prepared in November 2014 for previous explorer Rockridge of over 350 000 ounces gold (0,6 g/t cut-off) and was estimated for only the Fatou Main prospect and represent only part of the potential of the project.

"We are very excited about Fatou. This is an advanced exploration project with already defined gold mineralisation. We see lots of opportunities here for our geologists to target areas with potential to define significant gold mineralisation. Our initial reconnaissance is highlighting sites of artisanal mining that have not been drill tested. Our review of historic exploration is highlighting gold anomalies that require first pass testing, and finally our review of the defined gold mineralised areas is highlighting areas to expand along strike, at depth and in parallel geological positions. We think this is a great opportunity for Kodal and we are looking forward to getting straight into the project," he says.

Kodal's immediate programme will involve confirmation drilling of the defined gold mineralised zones and expansion drilling. The company will also undertake detailed geological mapping and interpretation to prioritise prospects for drilling. "We have secured over 300 km^2 of ground in a highly prospective region and we will be undertaking a major exploration campaign to test this project," says Aylward.

Targeting production at Garalo

Contango's Garalo permit occupies 62,5 km^2 in the Sikasso region of southern Mali, 200 km south-east of the capital Bamako and close to the Guinea border. The permit is surrounded by a number of multi-million ounce gold deposits and the region is home to some of the world's leading gold miners, including AngloGold Ashanti, IAMGOLD, Barrick, B2 Gold, Endeavour Mining and Hummingbird Resources, which has helped to establish Mali as the third largest gold producer in Africa.

"We are extremely excited about the prospects at Garalo. The project was acquired with the intention of bringing into production a small but highly profitable gold mine. We have, however, recently discovered that thanks to both reinterpretation of historic data as well as information not previously incorporated in the historic 320 000-ounce figure, Garalo is significantly larger than first envisaged, with the potential to be a sizeable, multi-million-ounce standalone mine, rivalling some of our neighbours in this world class gold producing region. We very much look forward to Garalo's future," says Esprey.

The next step, adds Esprey, is to start an aeromagnetics programme, followed by some drilling in order to prove the resource to the 43-101 Standard. Contango also intends to build a small heap leach mine to develop the oxide ore and generate cash flow that will fund further expansion.

Work continues at Sanankoro

Cora's Monro says given that there have been a number of significant gold discoveries in the country, many of which have turned into excellent gold mines, he is confident that Sanankoro can become a mine in the future. He also hopes that the project is just one of a number of opportunities the company has in its permit area.

"Last year we completed a scoping study on the project, which showed a high IRR project that we are looking to build on this year. We are initially targeting growth in resources and then following on from this a DFS before the end of the year," he says.

Cora will this year drill out a larger resource, complete a DFS and permitting before moving into construction. "It should be an exciting few years ahead of us. With a strong gold price and a highly prospective land package on top of our main Sanankoro project, it's an exciting time for Cora and we are looking forward to doing the work on the ground," concludes Monro. ■

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Partnership approach to tech collaboration at De Beers' VUP

Partnership will be the watchword in the technological collaboration between global diamond leader De Beers Group and engineering group Sandvik Mining and Rock Solutions on the Venetia Underground Project (VUP).

South Africa's largest diamond mine, Venetia has been mined as an open pit since 1992. De Beers Group is investing US$2-billion to start mining underground from 2022, extending the mine's life beyond 2045. The VUP represents the biggest single investment in South Africa's diamond industry in decades.

Allan Rodel, project director of the VUP, says that the use of technology is critical in building the mine of the future and will ensure the safety of its people, as well as create unique employment opportunities. He adds that the successful implementation of technology holds the key to further improve the mine's productivity and cost effectiveness, enabling the quality and accuracy required for precision mining. This will also provide real-time geospatially referenced data that supports digitalisation of processes and provide a wealth of data for analysis and continuous improvement.

The underground mine will use sublevel caving to extract material, from its K01 and K02 ore bodies. Initially the ore will be hauled to surface using a combination of underground and surface haul trucks. As the operation matures the hauling systems will transition to an automated truck loop in combination with vertical shafts for steady state production.

Simon Andrews, MD Sandvik Mining and Rock Solutions Southern Africa.

Leveraging technology

Prioritising safety and productivity, the VUP will leverage the technology achievements of Sandvik Mining and Rock Solutions, having ordered 19 units of high-tech equipment from the company.

According to Simon Andrews, MD at Sandvik Mining and Rock Solutions Southern Africa, the company will supply a range of intelligent equipment including load-haul dumpers (LHDs), articulated dump trucks (ADTs), twin-boom drill rigs, roof bolters and cable bolters. Amongst the advanced models are 17 tonne LH517i and 21-tonne LH621i LHDs, 51-tonne TH551i ADTs, DD422i face drills, DS412i roof bolters and DS422i cable bolters.

"As important as the equipment itself is, De Beers Group was looking to partner with a company who would support them through the VUP journey," says Andrews. "Taking a mine from surface to underground has many challenges, including the change in operational philosophy."

The Sandvik LH514 has been designed for use with AutoMine, Sandvik's mining automation system for increased safety, productivity and lower costs.

Collaborative effort

Andrews highlights that change management processes are as crucial to success as the capacity and performance of the mining equipment. The implementation of the new technology is seldom a straightforward process, and always requires a collaborative effort.

"The expectation of the customer is for a strong relationship with a technology partner who will help them to apply, develop and fine-tune the systems they need, over a period of time," he says. "This way, the technology is

assured to deliver the safety, efficiency and other positive results that the new mine will demand."

Andrews believes that Sandvik Mining and Rock Technology leads the pack from a technology point of view, having introduced its intelligent i-Series machines to enhance remote operation capability. This advanced range combines automation with powerful data management capacity, aligning with the philosophy that De Beers Group has applied to this world-class operation prioritising the safety of its people.

Also included in the package for VUP is the Sandvik OptiMine control system which enables continuous process management and optimisation, focusing on key areas such as face utilisation and visualisation of the operation in near real-time. Utilising data generated by the i Series machines, OptiMine helps mining operations to achieve the lowest operating costs and highest levels of productivity.

Andrews notes that Sandvik Mining and Rock Technology is not new to the Venetia site, having worked with Venetia's surface operations for some years, providing tools for drilling as part of a performance contract.

"We've been following the VUP with great interest and were ideally placed to contribute as we have extensive South African experience with mining customers in transitioning from opencast to underground," he says. "This has involved providing equipment, implementing the systems and getting a full operation running with the latest equipment."

Pushing technological boundaries

Andrews emphasises the extensive global footprint of Sandvik Mining and Rock Solutions, and its significant investment in ongoing research and development. This allows it to help customers push technological boundaries for efficiency in their operations.

"Sandvik Mining and Rock Solutions has successfully completed numerous large and ambitious projects, and it reflects our experience in applying automation technologies from first principles," he says. "The learnings from these projects will be seen in the VUP as the mining systems are rolled out. We will take the very latest technology and assist the mine to implement it in an underground environment through a collaborative approach using local skills and supporting it from a local base of expertise."

He emphasises that the automation will be applied through a phased approach, beginning with manual operation and closely monitoring performance through data analytics. Automation can be gradually introduced with the necessary training and experience, ensuring consistency of operation which is the key to success.

"This will allow costs to be driven steadily lower, using the data from the operation of the fleet to guide the transition to automation," he says. "We will work with the mine to introduce automation and further data management as work progresses deeper into the mine, and as mine employees become more comfortable with this way of working."

Sandvik Mining and Rock Solutions is geared to support the trackless systems implemented at the mine through the full lifecycle of the machines by supplying spare parts, tooling and components from an on-site Vendor Managed Inventory stockroom and its other South African based facilities. ■

Above: The Digital Trainer allows operators to start practicing before the actual loader arrives on the site, leaving the on-site equipment available for productive work.

Left: Sandvik partners with its customers to ensure optimal outcomes, and this includes training.

The Toro LH621i loader is an ideal match for three pass loading with the Toro TH663i dump truck.

Digital technology trends for 21st century mining

The Sibanye-Stillwater Digital Mining Laboratory (DigiMine) and the Wits Mining Institute (WMI) at the University of Witwatersrand hosted the annual DigiMine seminar in December 2020 with the theme, Digital technology trends for 21st century mining'. Modern Mining's *Mark Botha* attended the event and filed this report.

Prof. Frederick Cawood, director of the Wits Mining Institute.

In his keynote address, titled "A perspective on the future of mining: considerations for universities offering mining qualifications", Prof. Fred Cawood, director of the Wits Mining Institute (WMI), focused on the future of mining and on what the WMI is doing to address this future.

In his research, Cawood adopted an approach of identifying current issues to see whether there are underlying trends associated with them. He then pursued the identified trends to interpret which future scenarios they could lead to and, more importantly, what the implications for risk or opportunity management are.

"In these future scenarios," he says, "there may be opportunities, risks or challenges. In the case of opportunities, we simply need to carry on doing what we're doing to align our work with the prospective future scenario." The scenarios could also present risk, in which case there would be issues both within and without mining companies' control.

"In this case, the approach used in the research was to focus only on the issues we can control and to create awareness of the rest," he says.

The Sibanye-Stillwater Digital Mining Laboratory (DigiMine) at Wits University exposes students to different technologies and environments.

These issues were then grouped into four categories, namely business and operational issues (over which companies have control); political or sovereign issues, which include aspects such as resource nationalism; sustainability issues, as well as "cross-cutting issues", which fall in more than one category.

"This exercise showed that there are more issues within company and university control than without. This is an important observation as it means that it is possible to work towards a better future despite some of the factors beyond our control."

Dominant issues

The dominant issues that could be controlled at the time of the exercise amounted to 28 in total, including technology adoption; automation; difficult operating conditions; the 'politics of anger', and poverty and jobs.

He says that, in terms of technology adoption, the message is that "we are dealing with a structural shift,

an unstoppable trend of technology and 4IR.

"The machines are no longer coming; they are already here and they're becoming more intelligent by the day. We must understand and deal with this policy perspective within the African context of poverty.

"Mining conditions, including health and safety, are becoming more complex and difficult as mines become deeper or are developed in remote locations.

The challenges categorised as mostly outside company control include country debt and geopolitical risk; global trade wars; resource nationalisation; tax regimes; the COVID-19 pandemic; climate change, and social licence to operate, among others. These, however, says Cawood, affect mining and industry's response to the markets.

"There is the worldwide issue of the 'politics of anger', exacerbated by impatience and a new generation of people who think and approach 'traditional' tasks differently. The issue of poverty and jobs is exacerbated by the implementation of mining automation while people remain unemployed."

In the Wits DigiMine Control room are Wits students, Nonhle Phiri (left) and Peter Kolapo.

The future of energy

Other possible futures affecting mining include the future of energy. In the northern hemisphere, the energy problem centres around energy storage and zero carbon emissions while, in the south, the challenge is one of energy generation to fuel developing economies.

"We must be familiar with the differences between the two, especially in the African context," says Cawood. "In Africa, storage is not the big issue as we hardly produce surplus energy." Similarly, battery metals are aimed at northern hemisphere markets, where energy storage is the current need. These issues are context-specific, without single, universal solutions.

Another structural shift pertains to climate change and social licencing, the latter of which refers to the issues of the environment and social and corporate governance (ESG), which Cawood says are currently becoming an international form of 'soft' law.

He notes that infectious diseases such as HIV, Ebola, malaria and COVID-19 have plagued the worldwide mining industry for a long time, posing issues of risk management with which the mining industry can deal.

Cyclical and structural issues

Cyclical issues either come and go or are part of long-term, stable trends.

"With issues of a cyclical nature, we must learn from the past and innovate. Some fall within the company's control while others do not."

Cyclical issues within mines' control include security of mineral supply; capital management; challenging operating conditions; ESG compliance, and risk management. Those over which the company has no control include poverty and jobs; resource nationalisation; infectious disease, and macroeconomic uncertainty.

"Structural issues, on the other hand, are those which require urgent and 'deep' innovation. They include the issues that make many players in the industry 'uneasy', such as mine automation, which falls within the company's control." Climate change, which fuels the carbon debate, is another structural issue that can be controlled at a higher (national) level.

Some of the issues beyond companies' control which affect the minerals market include global trade wars such as those currently between the USA and China, as well as Brexit, where both Europe and the UK are on the lookout for new markets, notably in the East and in Africa.

Trend analysis

An analysis of the issues within our control (security of mineral supply; capital management; difficult operating conditions; ESG compliance; risk management, and automation and climate change) highlights trends emerging from each. The trends arising from security of mineral supply, for instance, are a worldwide demand for minerals and the de-risking of the supply chain.

In terms of capital management, the trend is increased competition for capital: "It is becoming more difficult and more expensive to raise capital due to the challenging operating conditions where the trend leads to value-add and better asset & resource management.

The trend in terms of ESG compliance is an increase in reporting and compliance requirements,

Automation of the mine value chain is a driver for value.

in an attempt to achieve balance while the trend emerging from risk management is causing a structural shift in risk management practices.

"With the rise of mining automation, a structural shift, we only have a vague idea of what the mine of the future will look like. This will be dictated by technology and AI, both of which are disruptors to mining and the future of work," says Cawood. The trends emerging from this shift are an increased pace of technology adoption and a disruption to mining and its future of work.

Another structural issue is that of climate change, where one of the trends is growing resistance to carbon emissions.

Opportunities

AI and human skillsets will determine how we mine, as technology and its application will determine what the mine of the future will look like.

Climate change issues and specifically extreme weather, on the other hand, will determine where and when we mine, while what we mine is determined by carbon content and the ability to control the release of carbon into the atmosphere.

Universities and research institutions can help the mining sector and the National Systems of Innovation (NSI) by researching mining methods for extreme depths, in addition to skills development and qualifications.

"There will come a time when we mine too deeply for people to operate or function in those environments" says Cawood.

He says the issue of circular mining, which includes working towards zero waste, is particularly difficult: "It is made even more difficult with the move from coal to battery metals in mining because metals mining generates much more waste than coal mining. So we have new challenges."

He describes automation of the mine value chain (MVC) as a driver for value. Work currently underway at DigiMine relates to automating the mining cycle in deep goldmine environments.

Artificial Intelligence

"AI can't be avoided. We need a building information modelling-like understanding of the MVC for mining. Building information modelling (BIM) is not a new concept and the amalgamation and different uses of software are providing us with such a BIM-like system."

Cawood says the extent of systems integration is determining the level of AI.

"This is the difficult part: integrating data so that it is ready for decision-making. AI is already visible in many of our work processes, although it hasn't been perfected yet."

He says skills acceleration is being achieved by strengthening the content of Fourth Industrial Revolution (4IR) sciences as a foundation skill. Skills acceleration must happen at the same time, as well as strengthening curricula and programmes with 4IR science content.

"AI technology can be adopted from other sectors such as the space sciences, where we have much to learn from the technology used in the Curiosity Mars Rover mission, where the Rover takes samples and navigates autonomously, on a faraway world which is difficult to reach."

How the future affects universities

Typical challenges in the future include the disruption caused by technology in terms of markets, mining, work and people, to the extent where technology and skillsets will determine how we mine.

Examples of the work done by DigiMine include the World of Work mentoring programme for graduates, as well as exposure to different technologies and environments, and social and

Key takeaways

- The dominant issues that can be controlled amount to 28 in total, including technology adoption; automation; difficult operating conditions; the 'politics of anger', and poverty and jobs
- The machines are no longer coming; they are already here and they are becoming more intelligent by the day
- It is becoming more difficult and more expensive to raise capital due to the challenging operating conditions, where the trend is value-add and better asset & resource management
- AI and human skillsets will determine how we mine, as technology and its application will determine what the mine of the future will look like
- Future risks include constantly changing skillsets, which will cause traditional learning programmes to become irrelevant

corporate governance issues. Future risks include constantly changing skillsets, which cause learning programmes to become irrelevant if they are not regularly reviewed and updated.

"This is a reference to the value proposition of the individuals themselves: people who simply complete tasks like machines will have their jobs taken over by machines. However, people who are creative and who understand the work will not be replaced as readily," says Cawood.

He says that, for universities, the measure of success is the employability of graduates in the new world of work: "This transition is fundamentally impossible without competence development, and the impact on learning programmes is that new content testing competence must be added to the existing curricula."

This new content relates to a strengthening of subjects such as computer, mathematical and geography sciences like GIS; the business side of the mining business; economics, management and leadership, as well as the regulation of mining and minerals.

WITS' response to the future

"Our aim at DigiMine is to give management and workers the right information to make the right decisions on mine health, safety and efficiency at the right time," says Cawood.

He says Wits University has separated the "fundamental" work in the School of Mining Engineering from the "applied work" done by the Wits Mining Institute.

"We do the applied work, skills development and research at the institute while the fundamental degree courses are presented at the school."

In terms of responsible mining, the Wits Mining Institute influences policy and legislation, and has launched a programme in partnership with Mining Dialogues 360 to understand artisanal and small-scale mining (ASM) and the distinction between ASM and illegal mining. The programme deals with policy and legislative shortcomings for governing artisanal mining to arrive at long-term solutions for this significant problem.

The WMI also invests in the "acceleration" of skillsets, as opposed to mining qualifications.

These skillsets, says Cawood, "go beyond" mining knowledge.

"An example is the skill of producing a heat map index, which is relevant in a 4IR context and can provide someone with a skill to do their job more efficiently – or make the difference in getting the job in the first place." ■

Right chute design can save high conveyor costs

Where chute systems are not intelligently designed and manufactured, mines will invariably face sky-rocketing conveyor belt costs. Weba Chute Systems maintains it is critical to ensure transfer points are appropriately engineered for individual applications.

"Where chute systems are not properly designed and manufactured, mines will invariably face sky-rocketing conveyor belt costs," says Mark Baller, managing director of transfer chute expert Weba Chute Systems. "A custom solution, on the other hand, can reduce these costs by three or four times."

A Weba stacker chute discharging onto boom conveyor demonstrating flow control and centralised belt loading.

Baller highlights that conventional chutes tend to allow run-of-mine material – often up to half a metre in size – to drop from considerable heights onto conveyor belts. This is a common cause of damage and significantly reduces belt life. Differences between the material's velocity and the speed of the belt also aggravates this wear. In addition to frequent belt replacement or repair, mines are faced with the disruption of unplanned stoppages and the unnecessary cost of this downtime.

"The answer lies in a holistic chute design that controls the flow, volume and velocity of material," he says. "This control is a key factor in reducing wear and tear on belts, while also cutting dust levels which are caused by the impact of falling material."

Weba Chute Systems achieves this through sound engineering principles, in particular by building the 'super flow effect' into its custom-designed products. The customer's application and environment are also studied in detail to ensure that each design is fit-for-purpose.

"Our years of experience with transfer points have given us extensive insight into the range of data that we need for appropriately engineering the solutions we propose to customers," he says. "This includes details of the product being moved and its consistency, the trajectory of the outgoing conveyor, and the transfer height."

He emphasises that Weba Chute Systems conducts on-site assessments to check that the data being used is correct. The company uses 3D scanning and leverages this data using sophisticated 3D software for the assessment of information ensuring that designs are optimal and accurate. Discrete Element Method (DEM) simulation is also used as a verification tool.

"Many mines are inclined to underestimate the value that can be added to both their process efficiency and their bottom line by good engineering design. Like all other key equipment in a plant, chutes need to match precise operational requirements – hence the need for a customised solution," Baller concludes. ■

Getting the right tools for mining to go digital

The astute application of digital tools is the key to continuously improving efficiencies on underground mines, according to Niel McCoy, business line manager for automation and digitalisation at Sandvik Mining and Rock Solutions.

McCoy says that the choice of digital tools needs to be based on each operation's key performance indicators (KPIs). This is because the solutions that are implemented will be focused on monitoring and managing those KPIs. He then recommends a phased approach to introducing digital tools to an operation.

"The starting point is always machine telemetry and basic production or productivity reporting," he says. "From there, the solutions can be expanded."

Sandvik OptiMine is a powerful suite of digital tools for analysing and optimising mining production and processes.

Sandvik Mining and Rock Solutions has extensive global experience in designing and implementing digital tools, including equipment health monitoring and process management. Its AutoMine automation offering operates on 59 mining sites globally, while its OptiMine suite of digital solutions is active on 66 connected sites. The 'My Sandvik' customer portal, a web-based digital hub, serves 214 sites and its Newtrax technology in wireless IoT connectivity is operating on 115 sites.

"Monitoring equipment health through My Sandvik Digital Services Solutions allows users to draw down telemetry data from their equipment in real time," he says. "The data is automatically compiled into the required report format for quick analysis and response."

The next aspect to be addressed is the actual management of the process being monitored, he says. This is where Sandvik's Task Management and Scheduler – part of its Optimine suite of digital solutions – can be applied.

"This allows a tablet to be fitted to an item of equipment so that an underground operator can accept tasks and provide real-time progress reports on those tasks," he says. "The more advanced the equipment, the more data can be extracted and communicated automatically without operator intervention."

The solutions allow for data to be recorded on equipment's key operations – such as the weight of loads in a loader bucket. Telemetry on the equipment gives valuable insights into the equipment's availability and performance – so that management can respond.

"When starting digital journeys, the focus must be on improving current operations," says McCoy. "This means getting work started on time, for instance, before moving onto optimisation efforts. Most digital implementations will battle if the starting point is trying to increase productivity before getting the basics right." ■

Kwatani grows its base of customised screening solutions

As leading vibrating screens and feeders specialist Kwatani has transitioned from equipment supplier to solutions provider, it has attracted customers from well beyond South Africa and even outside Africa. Its strong in-house expertise and design capability ensures that its customised solutions deliver optimal performance at the lowest possible lifecycle costs.

According to Kwatani GM sales and service Jan Schoepflin, the company's strong in-house expertise and design capability – combined with the world-class manufacturing quality it consistently achieves – ensures that its customised solutions deliver optimal performance at the lowest possible lifecycle costs.

"Our recent orders show that our customer base in Southern Africa remains strong, while there is growing recognition of our cost effective offerings in West Africa, East Africa and North Africa," says Schoepflin. "At the same time, orders from countries like Canada and Russia indicate that our markets abroad continue to grow."

Kwatani remains the market leader in the supply and servicing of vibrating screens and feeders on iron ore and manganese mines in South Africa's Northern Cape province. It also counts platinum, coal, diamond and gold mines in its customer base. Its West African orders have been mainly to gold mines, and there is growing potential for gold mining in East Africa, he says.

Over its four decades of operation, Kwatani has produced about 16 000 custom-designed screens, and is building on average 30 to 40 units a month in its ISO 9001:2015 certified facility close to OR Tambo International Airport in Johannesburg.

"Our reputation has been built on prioritising what our customers need, and doing business with integrity and trust," Schoepflin says. "This means delivering on what we promise, and making sure that customers achieve the expected value from our products."

He highlights that the company's solution-focus is underpinned by its significant and ongoing investment in local skills, ensuring that its designs leverage strong mechanical and metallurgical engineering expertise.

"This confidence in our products allows us to offer a process guarantee to customers, to deliver the tonnage, throughput and fractions that they expect," he says. "Depending on which country our customers operate in, they may also have different industry and quality standards/certification expectations and we work closely with them to understand these clearly and meet their requirements." ■

Large scalper screen leaving Kwatani for the end user in an iron ore mining application.

Metso Outotec delivers flotation technology to GTK's pilot plant

Metso Outotec will deliver new, smart flotation cells to GTK Mintec's pilot plant in Outokumpu, Finland. The delivery consists of approximately 20 pilot flotation machines and additional equipment.

GTK Mintec is replacing the flotation cells to modernise and expand its services. The new flotation cells will support the improvement of the monitoring of beneficiation studies and process design.

"GTK and Metso Outotec promote sustainable and competitive mining technologies. We are pleased that GTK chose Metso Outotec's leading edge flotation technology for their test facilities," says Stephan Kirsch, president of Metso Outotec's Minerals business area.

"The test plant and laboratory in Outokumpu offer mining customers a comprehensive service package. The whole production process needed for a mineral deposit can be tested there on the scale required by the research problem. Through the flotation investment, our domestic and international customers can use state-of-the-art technology in research related to battery minerals and circular economy materials, for example," says the head of the Circular Economy Solutions unit Jouko Nieminen from the Geological Survey of Finland, adding that Metso Outotec is a frontrunner in sustainable technologies. ■

Large screens for Nigeria show Weir Minerals' design depth

Two of the largest screens built by Weir Minerals Africa are being designed and manufactured in South Africa as part of a process solution for an iron ore mine in Nigeria.

According to Tiisetso Masekwameng, GM comminution at Weir Minerals Africa, the flowsheet accepted by the customer includes equipment for screening, washing and grinding supplied by Weir Minerals.

"Within our scope of work are the two largest Enduron double-deck banana screens built by Weir Minerals," says Masekwameng. "This is made possible by the depth of design expertise in our Separation Technology Group, an eight-strong team conducting research and development."

Tiisetso Masekwameng, GM comminution and Steven Hunter, technology group leader separation at Weir Minerals Africa.

Steven Hunter, separation technology group leader at Weir Minerals Africa, says the two 51-tonne Enduron double-deck banana (DBHG 43/97) screens for this project were built upon the designs of the Weir Minerals existing screens range. These large machines measure 4,3 m wide and 9,7 m long and can process 1 750 t per hour.

"The customer's production requirements demanded this considerable size, so we optimised the design by minimising mass without compromising structural integrity," says Hunter. "We conducted extensive finite element analysis (FEA) on the whole machine but focused on the main structural elements, ensuring that the units were fit-for-purpose while still being light enough to be driven by the exciters."

Nonetheless, the size of the units still demanded the design and manufacture of Weir Minerals Africa's largest exciter yet – the Enduron LTX 10. With 120 t of excitation force (at maximum setting), these units will drive the screens at a stroke of 9,4 mm and a gravitational force of 4,6 G. Hunter highlights the close collaboration between the research & development and manufacturing teams that contributed to the successful development and testing of the Enduron LTX 10 exciters.

"The screens are also ready to be fitted with our IIoT (Industrial Internet-of-Things) platform, Synertrex," he says. "This allows the machines to be monitored remotely; the system can measure the machine's performance any deviations arising that may require proactive attention."

The order for Nigeria also includes two Trio jaw crushers, two Trio cone crushers, two large 2-m by 8-m Trio apron feeders, two Trio pan feeders, eight Enduron vibrating screens and an Enduron HPGR (high-pressure grinding roll).

For the clay washing circuit, Weir Minerals Africa will supply the mine with a Trio twin-shaft blade mill and Trio twin-shaft coarse washers as well as Warman slurry pumps. ■

Updated Cat 777E improves performance and fuel efficiency

Offering what is said to be the highest in-class payload of 98,2 tonnes, the 2021 Cat 777E truck features improvements in power, torque and transmission control to deliver greater productivity. Updates also include configurable Eco Mode operation to reduce fuel consumption and drive down cost-per-tonne of material moved.

The truck's updated Cat C32 engine delivers increased horsepower and a 7% improvement in torque to increase hauling performance.

The updated Cat C32 engine delivers increased horsepower and a 7% improvement in torque to increase hauling performance. Optimised fuel mapping of the engine and adaptive economy mode determine the most efficient operating point to improve truck fuel economy.

Additionally, operators can select a variable engine derate from 0,5% to 15% in Eco Mode operation to further reduce fuel consumption – and the new automatic engine idle shutdown feature reduces fuel use and wear on engine components.

Today's 777E truck improves productivity by up to 5%. The new Advanced Productivity Electronic Control Strategy (APECS) improves transmission and engine coordination to better utilise available engine power. The result is as much as 7% more torque delivered to the drive wheels for improved hauling performance. The new control system also provides smooth shifting for greater operator comfort.

The 777E now offers a second gear start when underfoot conditions and grade allow. The strategy enables the truck to reach optimum speed more quickly, lowers cycle times and minimises the number of transmission shifts. To save fuel, a new auto neutral idle feature shifts the transmission into a neutral-like condition when the truck is idling in drive. The transmission's speed limit feature allows the machine to run at optimal gear for selected speed.

When working in cold conditions, the new auto-stall feature assists in quickly bringing the transmission to operating temperature at start-up. The effect is less non-productive time and reduced fuel consumed for warm-up.

The 777E also features updates that elevate operator efficiency. A new gearshift lever with integrated hoist and park brake controls eases operation, and the auto hoist feature delivers controlled truck bed descent to prevent body slams and increase component life. ■

East-West links support FLSmidth's thickener projects

The use of FLSmidth thickeners in African mining operations has continued to grow, supported by global collaboration across the FLSmidth organisation's offices in South Africa, China and the United States.

According to Alistair McKay, FLSmidth's vice president for Mining in Sub-Saharan Africa and the Middle East, the company is delivering six substantial thickener contracts to mines in Mozambique and the Democratic Republic of Congo (DRC) in 2020. McKay highlights that Chinese companies have been driving much of the growth in the continent's mining sector.

"In our work in Africa with Chinese customers, we have found that our Beijing office plays a valuable role in ensuring streamlined communication and efficiency," he says. "This allows a constructive combination of our local knowledge with the ability of our Chinese colleagues to facilitate relationships with our customers in China."

This differentiator has enhanced FLSmidth's acknowledged leadership in thickener technology in the region. The company will deliver 25 new thickeners, including high rate, high density and counter-current decantation (CCD) thickeners, in southern and central Africa during 2020.

"The design work for these contracts was conducted by FLSmidth's centre of excellence in the United States," he says. "Given our established local infrastructure and experience in this product range, the thickeners were cost-effectively manufactured in South Africa and China."

While the fabrication and platework was completed using local skills, the FLSmidth on-site technical support presence to construct and commission the thickeners at Chinese-owned mines in the DRC will integrate staff from the Beijing office.

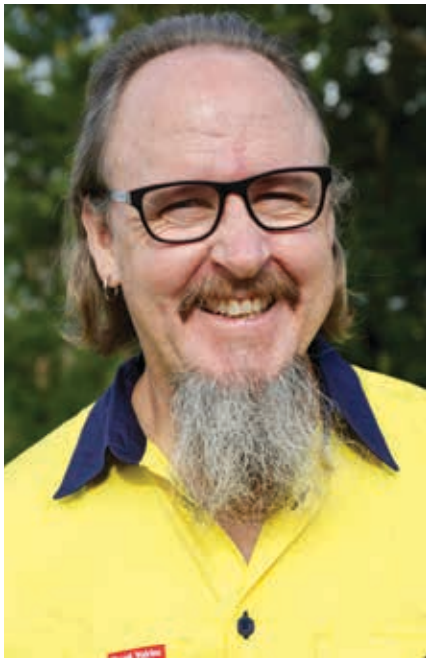
"This improved communication between FLSmidth and the customer has negated the risk of any misalignment that could slow the process down," he says. "In fact, our Beijing office has become increasingly involved in the full delivery process, fulfilling the role of the project manager. This is significant as the building of relationships across East-West contracts becomes increasingly important."

FLSmidth offers full-service capabilities in thickener technology, he says, starting with bench or pilot scale testwork to characterise customers' material. This informs the customer's flowsheet and equipment selection and sizing, and the right technology application for cost-effective, optimised operation. ■

The use of FLSmidth thickeners in African mining operations has continued to grow.

The rise of robotics: It's mining, but not as we know it

Mining has entered a robotics boom as developers take substantial strides in AI, use of drones, and data capture and analysis technology that will deliver safety improvements and better managed mines, says Queensland Robotics executive chairman *Andrew Scott*.



Andrew Scott, executive chairman at Queensland Robotics.

He told an IMDEX Xploration Technology Symposium that with the development of autonomous haulage and drilling technology, the mining industry had moved through a "trough of disillusionment" around robotics and was rapidly accelerating towards the "plateau of productivity".

The two-day online conference brought together experts at the forefront of innovation in the mining and exploration industries to discuss the latest in new technologies, tools and advanced analytics.

Scott said acceptance of new technologies had been aided by restrictions caused by the COVID-19 pandemic, with the development of some digital transformation projects planned for the next three to five years being executed in three months. "COVID is a significant accelerator and robotics is no exception," he said.

Capital was available to fund new and emerging projects and was another clear indicator of a robotics boom, which he said would undoubtedly mean more jobs not less.

"There is a lot of work that's underway right now to really bring to the forefront a lot of automation and robotics to deal with enhanced data capture and execution of exploration programs and also within the mining environment," he said in an interview ahead of the symposium.

Towards new technologies

"In the mining environment we have seen the proliferation of automation in the form of autonomous haulage and autonomous driving, but now we are seeing all the other ancillary services that are requiring automation and robotic solutions to take people out of danger but also to enable a highly efficient and productive system.

"We are starting to see some of those capabilities move across into exploration, including the ability to deploy smart sensors in the field robotically, the collection of samples, and the analytical processing of those samples."

He told the symposium the increase in robotics was aided by a reduction in sensor and computational costs, and with more tools and technology available there was increased adoption and acceptance.

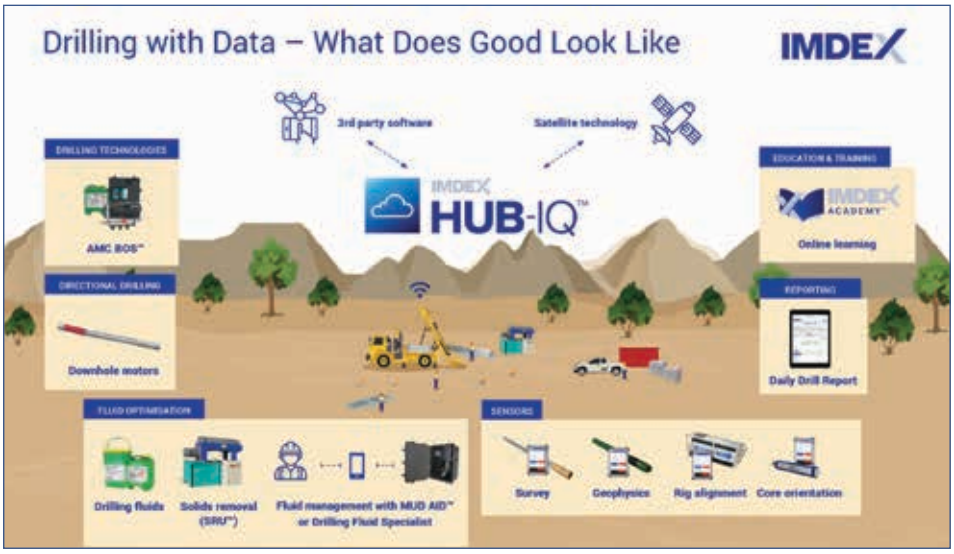
"Robots are helping with the dirty, dull and dangerous, and distance challenges," he said.

"Applying robotics can definitely remove people from harm's way. It can also augment what they are able to achieve by being able to explore in environments where until now we've been limited."

This included in Australia, with areas subject to extreme heat, the high altitudes of the Andes, and subsea exploration.

"Robotics is surfing the wave of AI. There is a huge amount of development and growth in this area. We have gone past the AI winter, as they call it, and the acceleration of tools, and the ease of use of those tools is becoming a critical enabler," he said.

"My prediction is that we are going to see more and more solutions where they are highly engineered highly capable, robust, highly configurable and easy to use."



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