Mining Magazine

# Take it to the limit: Deep-level mining

The industry is inching closer to standard operating procedures in deep and ultra-deep mining

*Mines will need to go to new depths to meet growing worldwide mineral demand*

**Underground Mining > Geomechanics-ground-control**

Comments

Share

**Jax Jacobsen**

The need for mines to go deeper is becoming ever more apparent as readily accessible minerals close to surface have all but disappeared.

"If you look particularly at metal mining, you will find that 200 years ago, the grade of extracted mineral deposits was quite high," Dr Horst Wagner, Austrian mining expert and the former chair of mining engineering and mineral economics at Montanuniversität Leoben, says.

"In Australia, you find that 150 years ago, they excavated copper ore with a grade between 2% and 3%," he says. As time has passed and existing mineral sources have gradually depleted, the returns have been much lower. "Today we are mining copper ore underground at grade 0.5% in South America," he says. "We've gone from 2-3% down to 0.5%, and it's been the same for many other metal ores."

These minerals have been depleted as economies have grown, he says, and current projections estimate that mineral consumption between 2010 and 2050 will more than double - which will require mines to go to new depths and companies to invest more in minerals exploration in order to meet growing worldwide mineral

demand.

Those miners who have already taken this plunge are encountering a host of problems, Dr Wagner, who spent a significant part of his career in South Africa heading the Minerals Council South Africa's research organisation, says.

"Sweden is one of the major producers of iron ore, and is beginning to mine at depths below 1,000 metres," he says. "It's now starting to experience serious problems with rock pressure, which leads to rock bursts, which can do damage to mining excavations." In Poland, where copper miners are excavating 1,200m below surface, rock pressure is also starting to complicate operations, Dr Wagner says.

Rock bursts, defined as the sudden release of energy that had been stored in the rock mass, can have serious consequences for the machinery operating underground, the miners who are working in the affected space, and the entirety of the excavation as a whole. It is not yet possible to predict rock burst activity, which adds uncertainty to deep-scale mining excavations.

Another complicating factor in these types of mineral excavation projects is the substantial increase in heat, Dr Wagner says.

"Heatstroke is a common feature [of deep mining operations], and it used to be one of the major reasons for fatalities in deep mines in South Africa in the 1930s," Dr Wagner says. This leads to a need for underground cooling, which significantly raises operational costs by spiking the amount of energy required for mining.

What will also drive up costs is the added step of having to bring mined rock up to surface.

"You need energy to transport the rock mined underground to surface," Dr Wagner says. "If you double the depths, you double the amount of energy to lift the rock to the surface."

## Out of necessity

Few places in the world have as much experience with deep and ultra-deep mining as does South Africa, and ultra-deep mining could soon be the standard form of operations.

However, the Minerals Council South Africa emphasises that much work needs to be done before ultra-deep mining develops further in the country.

"For the most part, stoping - drilling, blasting and cleaning - is still the order of the day," a Minerals Council representative says. "To address these issues - to ensure the health and safety of miners, to retain and create jobs, to prevent the premature closure of mines, and to provide these essential commodities to the world in a way that is economically viable - the industry together with other stakeholders is making a collective move towards modernisation."

This modernisation would come in the form of greater mechanisation of processes that would allow access to deeper regions and allow continuous mining; workers who formerly were responsible for stoping and excavating would be retrained in machine operations, thus ensuring jobs would be retained.

Though there remains one critical obstacle to expanding mines at depth in South Africa: the increasing cost of electricity.

Earlier this year, the National Energy Regulator of South Africa (NERSA) approved Eskom's electricity tariffs, increasing prices by 13.8% from April 1.

"As many gold and platinum mines were already unprofitable or marginal, with electricity comprising about 25% and 17% of gold and platinum mines' cash production costs respectively, the deep-level sector would decline further as a result of NERSA's approval," the Minerals Council points out.

## Work in progress

One company, Australian firm Gekko, is paving the way for underground technologies which could eradicate the need to bring mined rock up to surface. It released a new 30-tonne-per-hour model in March 2018 that was specifically upgraded to work in an underground environment, making it compliant with new underground and mechanical specifications. These upgrades included using particular construction materials, cooling of the work environment, air conditioning, fire suppression in the motor control centres (MCCs), and increased automation and instrumentation to minimise operator interactions, Gekko business development manager Nigel Grigg says.

"The detailed engineering process also enabled us to do in-depth analysis of interactions around the battery limits and the realities of operating and maintaining the plant underground," he says. "We've developed ore products and product handling and modelled loader/vehicle movements and maintenance interactions with an actual 3-D scan of an underground drive."

In the upgraded model, it will be possible to modularise the processing plant to ensure that it can be installed underground, Grigg adds.

TMAC Resources has already put the technology to use in its Hope Bay mine, located in Arctic Canada. TMAC has installed Gekko's C$72 million (US$54 million) Python Environomic processing plant, the first modular one of its kind, at the Hope Bay property. The processing plant is notable for its low height and its quick construction. At Hope Bay, the processing plant operates above-ground.

"The Python-style modules were important to [TMAC Resources] for delivery to the remote location and to accelerate construction," Grigg says.

Gekko is in talks with other miners for underground processors, and has completed detailed engineering for a high-grade underground copper mine in Australia. The company is also doing feasibility work for another Australian underground gold mine.

"Both mines are getting deeper and looking to pre-concentrate, and send concentrates to the surface plants," Grigg says. "The tails will be backfilled into existing underground voids."

Underground processing will become increasingly important in the mining industry within a decade, Grigg predicts.

"At this stage, some of the mines that are getting deeper and do have excellent grades and tonnes available do understand the potential of underground pre-concentration," he says. "These mines are becoming increasingly marginal and need to do something to stay in business."

He has seen other companies taking steps towards considering underground operations and processing.

"I still believe that it will be another 10 years before the technology is accepted as a feasibility-stage flowsheet option."

## Underground rock habits

Despite these advances, there is still so much to be learned about underground rock formations and how and why they shift.

The time required to access deep-level resources is also a challenge, Dr Francois Milan, of the South African National Institute of Rock Engineering (SANIRE), says.

"It takes two or three shafts to get to the required depths, and then to try and mine outwards from that ... it will take a long time to tunnel down the complex shaft system and then travel to get to that work area," he says. One way to address the problem is for mining companies with neighbouring mines to collaborate more, particularly if the other mining company has a shaft which is closer to another company's deposit.

For engineers at US-based mining engineering consulting group Itasca, the challenges in expanding mines to depth are foundational.

"It's important to recognise the importance of the discontinuities of rock," Itasca's principal consultant Loren Lorig says. "A lot of people treat rock like soil because it's the easiest thing to do, but it's not necessarily the right thing to do. We look at the behaviour of jointed rock, and the role of brittle fracture because of very high stresses, which is a challenge to understand and to represent and simulate in mining."

One area that requires more research is understanding how different types of rock behave with stresses, he says.

"We understand strength and short-term strength, long-term is a different issue," Lorig says. "How strength changes over time is an area where there needs to be work done."

## Future of mining research

Dr Wagner, who headed the South African Chamber of Mines Research Organisation (COMRO) before it was incorporated in 1992 into the Council for Scientific and Industrial Research (CSIR), is concerned that mining research is declining precipitously in the developed world.

"Thirty to forty years ago, there was a lot of research activity taking place at state-operated mining research organisations," he says.

"With the closure of mines, these mining research organisations no longer exist," he adds, pointing out examples in Germany, France, the UK and the US. The vast majority of mining research now takes place in China, he says, and largely for the service of Chinese coal mines.

"This is a real problem," he says, emphasising that the dearth in mining engineering graduates is coming at an unfortunate time for the industry, when new and more complex problems will need to be solved to ensure access to minerals.