Chelopech revitalised

Donna Schmidt takes a look at the optimisation improvements and other updates made at the award-winning Bulgarian gold-copper-silver complex

To say the Bulgarian group, part of Canadian-based gold miner Dundee, has optimisation down to a science would be an understatement. Mineral potential at the property was discovered in the mid-19th Century, rediscovered in the 1950s, then several decades later grown by Dundee into the modern mine it is today.

The operation has built upon its knowledge and expertise exponentially in that time, and has evolved from a traditional mine to today’s cutting-edge operation.

Dundee has transitioned the mine’s extraction method, implemented process upgrades that brought the mine significant improvements, and has even managed a sizable drop in electricity and water consumption.

A LITTLE HISTORY

Chelopech’s history is comprised of many layers. The mine opened in 1956, shortly after Sofia Geological Exploration rediscovered the deposit from which the outcrop had been mined earlier in the 20th Century. The mine went on to be fully operational, including its plant, from 1970 to 1990.

It was then that the Bulgarian government issued a decree that Chelopech’s concentrates could no longer be treated at the MDK-Pirdop copper smelter due to a high arsenic content. As a result, the operation was placed into care and maintenance for three years.

In 1993, thanks to work by Bulgarian-Irish company BIMAK AD, operations restarted and the mine also retreated about 100,000t of stockpiled, low-grade concentrate that had been left behind from its days of being state owned.

By 1999, state-owned company Chelopech EAD operated the mining segment of business. By force of a privatisation contract, the majority stake of 75% was picked up in June 1999 by Navan Mining’s Navan Bulgarian Mining, and business began under the name of Navan Chelopech AD.

Navan filed for bankruptcy in 2002. In 2003, DPM purchased Navan’s Bulgarian assets, including Chelopech, renamed it Chelopech Mining EAD, and ultimately became a sole-owner company. Chelopech Mining EAD has served as independent operator of Chelopech’s ore mining and processing business since 2005.

Dundee, knowing the high-arsenic issue with the copper and gold concentrates, developed a project to augment throughput and upgrade the process at Chelopech so production metals could be directly sold to end users while also transforming the ore’s arsenic to an environmentally stable form that could be disposed of at a tailings management facility (TMF). The Bulgarian court stepped in, disallowing the project’s start, and Dundee subsequently purchased the Tsumeb smelter in Namibia in 2010.

“When Dundee bought the Chelopech mine, it was a rather unattractive prospect. However, investments in all spheres of production turned it around and the mine is now a high-performance, lower-cost business,” says Iliya Garkov, company vice president and executive director for DPM Chelopech and DPM Krumovgrad.

One vital element to the success: DPM’s strategy to change from sub-level caving, the historic mining method, to an open-stopping mining with backfill.

“Changing to the open-stopping method brought significant reduction of ore depletion as well as improvement to the environment, since large areas damaged in the past from the caving method were rehabilitated, thus bringing back the area in state forestry land for use to local communities,” Garkov adds.

CHANGES AND EVOLUTION

Since the acquisition, the miner’s mission has been continuous improvement, including efforts to increase production to 2Mt/y of ore.

“In the intervening 13 years, DPM has invested close to 90% of its profits to transform the mine from an undercapitalised operation into a modern and viable one that meets international standards for worker safety, environmental protection and sustainable development,” Garkov says, adding that it has invested in its people and improved the working environment significantly.

Some of the biggest changes Dundee has made at Chelopech include the development of a new decline; installation of an underground crusher and conveyor system for hauling the ore; upgrades to the mine’s ventilation system via a new and highly efficient fan at its Sever shaft; and upgrades to the Chelopech TMF.

Significant process plant upgrades were also completed, including the commissioning of a SAG mill and four high-capacity flotation banks to replace 26 existing units; the installation of two concentrate and flotation thickener trains; commissioning of a paste fill plant and a related under-
ground system; and the reconstruction of the ore stockpile and construction of a feed system for the plant’s SAG mill.

“The installing and commissioning of the new facilities resulted in achieving maximum efficiency regarding operations’ management,” according to Garkov.

“Undoubtedly, the improved management of all aspects of the environment comes as a result of the large-scale investments and introduced production innovations.”

**TODAY’S CHELOPECH**

Sub-level caving was employed at the mine through 2005. Between the 1980s and early 2000s, several caves above a total of four production blocks resulted from the method and, using its historical knowledge of both caving and expected geotechnical changes, DPM concluded the method could no longer continue to be Chelopech’s primary mining method.

The mine went on to examine the possible alternatives via research programmes, and found that the mineralisation types, geotechnical considerations and the orebody’s location lent themselves well to the long-hole stoping with fill method as the mine was planning to continue extraction at depth. Thus, sub-level caving has progressively been disappearing from Dundee’s mine plans for the operation since 2003 and operations have been replaced with a long-hole open stoping with fill (LHOS or LHSF) method.

Garkov notes that a horizontal rock pillar was designed between the upper caving areas of the orebodies to the stoping areas below to ensure a safe transition from sub-level caving to LHSF and allow mining operations to progress continuously.

“The LHOS approach improves ground stability, ensures maximum utilisation of waste rock for backfilling purposes, reduces the amount of tailings reporting to the TMF and prevents ingress of surface runoff into the mine,” he explains. “With the new mining method, this type of waste material is used for stope backfilling directly underground and is hence fully utilised on the site where it’s been generated.”

One key benefit from a landscape and environmental standpoint is a 40%-per-tonne-mined reduction in flotation tailings in the TMF. Others are a thorough utilisation of waste rock as backfill material, the prevention of surface cavings and waste-rock stockpiles above ground, and environmental protection both for the surface and the groundwater.

**FLEET AND TRANSPORT**

The heart of any mine is its mobile fleet. Chelopech’s underground mine production equipment includes six Sandvik LH517 load-haul-dumpers (LHDs) and seven Sandvik TH550 articulated trucks; four jumbo drills, including two Sandvik Axera 7-260s and two Sandvik DD422i units; and
four production drill rigs, including one Solo 7-7Cabin and one Solo DL420-15C, also from Sandvik.

Ore is transported to the plant via a materials handling system, an infrastructure effort that first started in 2010 to ensure Chelopech had the best reliability and operating efficiency as it expanded to 2Mt/y – in fact, its capacity is sufficient to help the mine reach as much as 3Mt/y.

Underground crushing is handled in the Western Area with gravity feeding a crusher via an orepass system to 195m. The ore is then belted from the 155m level to the surface with a 4km-long conveyor located in the decline.

“This system requires that the ore production from the blocks in the Western Area above the 195m level and the production from B151 mucking to be dumped in ore pass one,” Garkov says, adding that production from 195m and above in the Western Area needs to be trucked or mucked directly to the crusher tip point.

DPM has developed a second orepass, referred to as COP-2, between the 195m and 225m levels to manage ore from Central Area blocks, which accounts for 24% of the total mineral resource. This, too, allows for continuous production and, once extracted, can also be trucked to COP-1 via its link ramp 220-270 connecting the two primary areas of Chelopech.

ORE PROCESSING
Following a trip through underground primary crushing with the Sandvik CJ 615:01 jaw crusher, 400t/h of throughput travels to the surface stockpile on a trail of eight conveyors.

Once there, grinding begins with a Metso semi-autogenous grinding (SAG) mill 4.7m length/8.5m diameter in closed circuit with a cyclone cluster, then bulk sulphide flotation in Outokumpu 100 tank cells as well as selective flotation of both copper/pyrite in Denver 500 and Denver 300 flotation banks. Concentrates of both are then dewatered through high-rate thickeners (Delkor -12m and Outotec -18m) and Metso VPA pressure filters. Flotation tails are thickened to 50% and solids are sent to the TMF or used for paste back-fill in the mine.

The facility’s average daily throughput has been 6,692 dry metric tonnes this year.

Concentrates travel by belt for direct loading to railway wagons on-site, then are railed to the Bourgas port to be loaded and head off by ship to Namibia.

Regarding the environmental aspect of mining, DPM officials stress that safe, environmentally friendly solutions are used as part of its mission to be responsible to future generations and protect human health, as well as the environment overall.

“We maintain high ethical standards of communication with all stakeholders, and we follow best available techniques to reach production efficiency and ensure sustainable development for the region we operate in,” Garkov adds.

OPTIMISATION
DPM notes that, once the upgraded process plant was commissioned, it was able to cut its fresh water abstraction from the Kachula Reservoir by half. This occurred primarily because the miner had optimised the reclaim water system, and it now recycles more than 90% of water back in to the process.

“The new concentrate and flotation tailings thickeners, together with the filter press enable water recovery and recycling at the plant. This not only minimises makeup water requirements, but also reduces the electricity costs of the return water pumps at the TMF due to reduced operational requirements,” Garkov says.

The upgrade and expansion of mining to 2Mt/y had another positive impact on DPM’s path to optimisation for Chelopech, one of them being a reduction in electricity consumption by 20% per tonne of ore treated. This benefit, the miner says, stemmed from the management and control of the reclaim water system, along with improvements it made in the mine’s ventilation system.

The aforementioned underground crusher and conveyor system had a ripple effect as well: consumption of diesel fuel has fallen. According to DPM officials and material handling consumption fell by 40% of o re since the infrastructure was commissioned in February 2013. “With the new material handling system now complete and linking the underground mine to the surface, the mining cycle is closed, thus ensuring protection of the environment and human health,” Garkov adds.

Yet another achievement post-expansion includes a reduction in greenhouse gas emissions (GHG). While the Europe 2020 strategy outlined recommendations by EU member countries on reducing their carbon footprints, DPM had its own reduction target of 20% (tonnes of CO2 per tonne of ore) by the same year versus 2009, which is considered a baseline year.

The company beat its goal by the largest spread in 2012, when it reduced GHG emissions by more than 30% versus baseline, and there has been an upward trend towards continued gradual reductions in the years since.

AWARD WINNING INNOVATIONS
With all of the improvements that have been and continue to be realised at Chelopech, it comes as no surprise that the hard work of its people has been worthy of recognition.

One of those was from the International Mining Technology Hall of Fame, which bestowed onto DPM and its chief executive officer Rick Howes its 2016 Outstanding Innovator award.

Another honour that Mining Magazine readers will already know about is the company’s crown pillar project, which earned our 2016 Technology award.

As part of this, the mine’s team needed to develop a strategy for mining out a 30m crown pillar safely in a complex geotechnical environment – specifically, that it was left behind between the historical cave zone and the underlying orebodies where LHSF was employed. At the root of its obstacle was roof stabilisation for the planned production stopes in the pillar lying beneath a 600m-high cave full of unconsolidated rock.

Design ideas were analysed, and consultations were carried out with equipment suppliers to evaluate whether grouting or shotcreting could be suitable options. The company’s ultimate solution was an artificial roof
above the stopes, created by consolidating and reinforcing the caved rock. It resulted in the safe, efficient extraction of half of the crown pillar.

To date, six production stopes in the crown pillar have been successfully mined, with ore loss of about 5%—standard for the method under normal operating conditions.

“The project was successful, as everybody within their own role and responsibilities at all levels was highly engaged in the process and did their work well,” Garkov says, noting that the crown pillar extraction at Block 150 is still in progress today and continues to provide valuable experience to those involved.

He stresses that both awards exemplify DPM’s staunch commitment to its people, the industry and the future of the Chelopech mine.

“The site facilities and technologies are now fully upgraded. The funds we invested in environmental protection resulted in visible and environmental improvements. Our community investments have resulted in major improvements in a region, where mining has been the traditional business for more than a century.”

Dundee prides itself on its partnerships and cites those relationships for its ability to accomplish a modern mining operation. Some of those collaborations with global mining contemporaries and IT companies have borne fruit; one example is its development of an integrated management approach to its mining operations.

“Chelopech can now be monitored in real time, similarly to any open pit. The Integrated Management System was introduced in 2012, which was a new approach never tried in underground mines before,” Garkov explains.

“At the moment, the Chelopech mine continues its improvement efforts and the mining efficiency rate has increased by 10-30%.”

The company has also committed to improving efficiency through fostering the development and growth of innovations and expertise within the Bulgarian mining industry.

“That fosters an environment, where new mining and processing technologies can be applied for both lab-scale and industrial-scale projects, as they bring the mining business to higher levels by incorporating digital management and highly efficient technologies,” Garkov says.