



# Laiva's new lease of life



**Finland is set to welcome a new gold mine to its ranks this year, and Dan Gleeson found out how the operation is set to benefit from a restored “mine to mill focus”**

**T**he Laiva gold mine in northern Ostrobothnia, Finland, is set for a resurgence, more than four years after the operation closed down under former owner Nordic Mines.

With Toronto-listed Nordic Gold (formerly Firesteel Resources), the operation is set to pour first gold this month as it ramps up to a throughput level of 2 Mt/y.

Nordic Mines AB previously operated Laiva from 2011 to 2014, spending more than €220 million (\$254 million) on the development of two openpits, a 6,000 t/d milling and CIL circuit and other infrastructure.

The new owner, as a result, estimated it can bring the operation back online for some \$7 million in pre-production capital expenditure in a recent preliminary economic assesment (PEA).

That isn't to say Nordic Gold is simply putting a different logo above the mine entrance and following the previously laid out process – far from it.

As Joe Ranford, Chief Operating Officer and Laiva General Manager, said on a site visit in August: “Getting an understanding of what happened before is quite a big part of how we move forward.”

Anybody that followed Laiva under its previous owner knows there were a few operational issues that led to the mine's downfall.

The PEA carried out for Nordic Gold by John T. Boyd Company went into this in detail:

“The project as originally configured by the

previous operator proved to be sub-economic, owing in part to financial issues incurred by the prior operator but, perhaps, more significantly, as the result of inaccurate previous resource modelling and attendant mining practices which resulted therefrom.

“The recent operator sought to mine the resource by large scale open-pit bulk methods. This mining practice resulted in mining dilution of the actual mineralised zones, which manifested as significantly lower than expected head grade to the process plant.”

The head grade was never reconciled at the 1.2 g/t Au level the company forecast. In fact total gold production of just over 79,000 oz from 2.8 Mt of mineralised material equated to an average of 0.9 g/t Au and a recovery of 79-85%.

On top of this, the previous operator was sending hard un-mineralised granite to soft, well mineralised metavolcanics through to a grinding circuit not designed for such a blend.

This, in tandem with impromptu maintenance, led to the mill significantly underperforming the design feed rate, except during brief periods.

## **Sampling, sampling and...sampling**

This is all changing under Nordic Gold, with Vern Langdale, Laiva Mine Manager, saying the company has instilled a “mine to mill focus”.

This focus has seen the company employ strict controls to ensure ore and waste are mined and treated in very different ways.

When **IM** visited in August as part of a Finland

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Mine Safari, Nordic Gold was carrying out grade control drilling and combining this with in-pit production drilling control on 2 m by 2 m spacing.

Blasthole chips were, meanwhile, being sampled offsite to ensure the company was producing the optimal blend of material for the downstream process plant.

The explanation for this – and possibly the reason the company is pushing ahead with production based mainly on an inferred resource calculation – is down to the deposit's geology.

While there tends to be a regular layer of 10 or so metres of glacial till on top of the mineralisation at Laiva, the orezones are quite complex with short structures, according to Langdale.

As the PEA states: “Mineralisation comprises sheeted quartz-sulphide vein arrays within multiple, sub-parallel, mylonitic shear zones, hosted in metavolcanic and quartz diorite rocks.”

Parasitic folding is commonly observed, with several generations of faults recognised.

All of this means the company cannot employ the same type of bulk mining methods the previous operator used if it wants to turn a profit.



### Fleet

Back in August, the company was moving some 200,000 bcm/mth of material, with Langdale saying this would step up to 500,000 bcm/mth at full 2 Mt/y capacity.

It plans to mine from two recently-dewatered pits during the six-year mine life. The North Pit comes with a 1:5 strip ratio, while the South Pit averages out at 1:10.

The ore and waste mining is being carried out by Tallqvist Oy, the main contractor, through a mixed fleet of drills, excavators, haul trucks, wheel loaders and ADTs.

A mixture of Epiroc ROC L7s, Epiroc ROC D7C, Sandvik DX780 and Sandvik DX800s are carrying out production drilling on site, with Orica supplying the low-density emulsion for blasting.

The company is soon to move to a high-density emulsion and intends to set up an emulsion plant where it can store some two weeks' worth of supply.

Nordic Gold is also employing electronic detonators to improve fragmentation, material movement and ore dilution throughout the blasting process.

The blasted material is moved by 10 excavators. This includes one each of Cat's 314C, 324, 330, 336F, and 352F machines, plus four larger excavators – two Cat, 374Ds, one Cat 390, an Hitachi EX 1200 and a Komatsu PC 800. These machines load either Komatsu 605-7 (six on site) or Caterpillar 769/772 haul trucks, Volvo A40, A30 and 35D ADTs or three wheel loaders (LiuGong 535 II, Cat 980M and Cat 988G) depending on waste/ore classification and payload requirements.

The drilling, blasting, loading and hauling fleet is complemented by three dozers – one Cat D8R, another Cat D6R and one Komatsu 85EXE.

### Recovery mode

When it comes to milling operations at Laiva, Nordic Gold is not concerned about using the same flowsheet as the previous operator.

As long as the company provides the circuit with a reliable blend of material, it should receive the desired results.

The 2 Mt/y capacity mill was designed by Metso and is made up of a variety of Outotec and Metso equipment. Nordic Gold expects a headgrade of 1.45 g/t Au and a recovery rate of 90.4% from the plant: some increase on what the previous owner was getting out of it.

The flowsheet has been designed to cater to the hardness of the rock, with some of the high-grade sulphides circulating four times before making it through to the CIL plant.

Processing of mineralised material consists of three primary components – grinding circuits, pre-concentration by flash flotation and gravity concentration, followed by high and low grade leaching circuits.

This starts when mineralised material (no bigger than 1,000 mm) from the mine is transported by truck to the crusher feed hopper. It is crushed by the 700 t/h Metso C 160 jaw crusher to -200 mm and stockpiled.

From the stockpile, the material is fed through four vibratory feeders and onto a belt conveyor destined for the primary Outotec 250 t/h AG mill. Installed power on the AG mill is 3 MW, providing a specific grinding energy of 9.5 kWh/t, corresponding to 50% of the total grinding energy. Water is added to the AG mill in order to reach 65-70 weight-% solids in the finest (-8 mm) discharge system.

Secondary grinding is carried out by an Outotec 3 MW pebble mill, which uses 50-150 mm sized pebbles from the AG mill as grinding media. This mill provides a specific grinding energy of 9.5 kWh/t, corresponding to 50% of the total grinding energy.

To increase mill throughput, two Metso cone crushers in series re-crush the excess amount of critical size (8-150 mm) from the AG mill discharge material. The feed to the cone crushers is designed to be 35%, or 87 t/h, of the AG mill feed. The critical size is re-crushed down

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to -20 mm before returning back to primary milling.

A double trammel Metso screen then separates the discharge into three sized products – fines (-8 mm), chips (8-50 mm) and pebbles (50-150 mm). The fines material, together with the discharge from the pebble mill, report to a two-deck Metso scalping classifying sieve and secondly to a Multotec cyclone cluster.

From the sieve, the undersized flows by a split box with three exits:

- Cyclone feed pump;
- Flash flotation;
- FLSmidth Knelson gravity separator.

The 12-piece cyclone battery classifies particles for tails leaching. The coarse particles report back to the pebble mill for regrind, while the cyclone overflow acts as the feed to the low-grade leaching circuit. The targeted particle size of the cyclone overflow is P80 ~ 100 µm.

The flash flotation unit produces high-grade concentrate of gold-bearing sulphides such as arsenopyrite and pyrite. Copper sulphate is added to activate arsenopyrite and potassium amyl xanthate and aerophine 3418A are used as collectors. The produced concentrate is directed to regrind in a small ball mill, while the tails from flash flotation is circulated back to primary cyclone cluster for re-classifying. This process is automated by a Metso system.

The Knelson gravity separator, meanwhile, treats the majority of the flow and directs the concentrate to the small ball mill for further grinding before subsequent cyanide leaching.

Design of the low-grade leach circuit, carbon adsorption, elution and gold recovery circuit is based on a nominal throughput of 245 t/h, containing an assumed 0.77 g/t Au, 0.004% As and 0.022% S.

The high-grade leach circuit, carbon adsorption, elution and gold recovery circuit is based on a nominal throughput of 5 t/h, with some 68.2 g/t Au, 22.7 g/t Ag, 1.2% As and 5.9% S. This is likely to be increased to 10 t/h to meet planned throughput requirements.

Air is sparged into the leach tanks to improve the overall leaching rate, while cyanide levels are monitored for optimal distribution by an Orica control system. The process is partially automated – cyanide is measured manually and timers are set according to the results received from test work, Nordic Gold told *IM*.

The reason for the two streams – high and low grade – is tied to the tailings, with high arsenic-containing material requiring a different storage process.



Around 97% of tailings (low grade) is made up of fairly inert sand-like material fed out to the company's tailings pond, some 7 km away. Only 3% goes into the bitumen-lined sulphides ponds that need to be treated in order to release into the wider environment.

A Valmet/Metso DNA system acts as both the automation and SCADA system for the mill.

Gold is electro-won onto steel wool cathodes in the electrowinning cells and precipitated onto the bottom of the cell by direct current. A gold sludge is oxidised in a calcine oven for several

hours before the iron present is oxidised during smelting with the molten metal poured into moulds until solidifying into doré.

### Mid-tier ambitions

Nordic Gold's ability to both lower the forecast all-in sustaining costs of \$974/oz and increase the planned gold production may be somewhat inhibited by the existing infrastructure it has acquired as part of its cut-price deal.

Outotec previously ran sensor-based ore sorting trials on the project (when the mine was

*Nordic Gold is using a variety of grade control measures to ensure the distinction between ore and waste is well defined*

closed) which reduced the amount of waste and increased the head grade.

But, falling tonnages is not necessarily a good thing when it comes to filling the 2 Mt/y plant and achieving the best utilisation rate.

This is where Nordic Gold is hoping exploration next year comes up with some interesting prospects that can prolong the six-year mine life as well as, potentially, boost the 75,981 oz/y production profile.

One of three exploration properties the company owns 100% of was talked up during the site visit.

New Hope is some 300 m west of the current North Pit, over the other side of a haul road, and comprises a 150 m by 50 m gold-arsenic-copper anomaly. The prospect has previously been followed up with two channel samples and three exploration drill holes, the best of which returned 1 m at 4 g/t Au.

President and CEO Michael Hepworth has a dream of turning Nordic Gold into a much larger prospect – he said “mid-tier, Scandinavia-focused gold producer” during the site visit – so one would expect this and other exploration prospects to be followed up as soon as doré starts coming out. 