

CASE STUDY

Raise-bored slot raises

According to TRB-Raise Borers' CEO Jarko Salo, during mine production, raise boring is seldom used.

"Despite its many potential benefits, its lack of mobility makes raise boring an unattractive alternative for production drilling," he explains.

Slot-raise drilling is the most suitable production drilling application for raise boring. Slot raises refer to relief holes within a stope, intended to provide void space for blasting, thereby allowing 'expansion' of the blasted rock and improving fragmentation.

Nowadays, there are several methods used in mines to produce these slot raises: long-hole rigs, manual drilling methods and even conventional raise boring.

To increase production in an underground operation, any slot-raise rig must reduce the production complexities and simplify the mining process. While the potential is certainly there, the challenge is to make raise boring an appealing alternative.

"To utilise the benefits of conventional raise boring while also addressing the drawbacks, it soon became obvious that an entirely new type of highly mobile, self-contained raise borer for underground production drilling had to be built," notes Salo.

This new unit had to include several capabilities: rapid machine setup, to effectively drill holes that were suitable for production and to be suitable for swift dismantling/relocation.

Such a unit would also not require a concrete pad, no additional rock works, nor any special utilities or provisions other than the ones already established for the equipment operating in the same drifts.

Agnico Eagle's Kittilä gold mine in Finland commissioned such a

unit. The mine uses the sub-level stoping mining method. The average stope height is 25m but can be as high as 40m.

Each stope has two accesses: the overcut and the undercut. The original long-hole open stoping method required 21 drill holes for opening a drop raise in each stope, using the same conventional long-hole rigs as used for drilling blastholes.

The drop raises required five to six workdays to construct, including all the drilling, blasting and hauling stages, and necessitated the use of two drill rigs and several members of crew. Using long-hole drilling for the drop raises not only doubled the number of holes required but also made it necessary to blast the drop raise in five-metre breaks, which requires a lot of space as well as multiple work stages.

There was also a safety consideration involved in this process. Due to the challenging rock conditions presented by the sulphide-rich mineralisation, the method also required re-drilling after each blast in order to open closed holes.

Re-drilling holes after blasting is inherently risky due to the potential for encountering 'live' detonators that could trigger an explosion during re-drilling.

The mine replaced these drop raises with raise-bored slot raises. Now, with a raise borer, all work stages and complications could be replaced with a single machine, a single operator and a single work-order.

The new method also eliminates the safety concerns associated with explosives because raise-boring slot holes make it unnecessary to blast at all before the actual production blasts.

The solution was developed by TRB-Raise Borers when the RHINO 100 raise borer took over in July 2014, and the conven-



tional long-hole top-hammer drill rigs were assigned to other tasks.

The rig itself is an articulated, highly mobile unit capable of carrying all the equipment necessary to drill a 30m slot raise. This means the operation and setup follows the same principles as with any mining jumbo or long-hole rig operation.

Hydraulic jacks and stingers are used to establish the drilling position, with actual drilling starting immediately afterwards. Indeed, the first piece of drill string is already attached to the gearbox. This design integrates dust suppression and a muck chute to create a dust-free drill site and take the cuttings away from the rig.

Salo explains that to achieve the best raise-boring performance, the rig and the tools are designed to work as one integral unit.

The raise-boring tools are manufactured by Sandvik. The combination of an 11in (279mm) pilot bit and two raise-boring cutters allows the raise to be completed in a single pass.

The drilling concept utilises

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the bottom of the learning curve. From there on, the pace improved up to eight stopes and 410.3m/month in October 2014, three months after commissioning. The output over the entire year totalled 64 stopes, 11 mine infrastructure shafts and 2,993 drilled metres.

"We now need only two blasts, even for those 40m stopes, and opening up the drop raises in five-metre breaks has been eliminated altogether," underground planning engineer Elen Toodu, points out.

"Before RHINO, we couldn't imagine blasting 145 stopes a year. The stope cycle time has become significantly shorter.

"This has also freed up the long-hole rigs for drilling the actual blastholes instead of opening up drop raises. This job previously required 30% of our long-hole drilling capacity without adding basically anything to the tonnage."

The calculations originally

showed that many stopes would only need one slot hole, but the decision fell on two holes per stope as a standard and three in difficult stopes to maximise the security of the process – an easy decision to make especially as it does not compromise the productivity.

Drilling both slot holes with the RHINO 100 takes two days instead of the five to six required for the drop raises by traditional long-hole drilling.

"In conclusion, the success in this new process has offered some significant benefits for the mining operations at Kittilä. The quick and easy solution for drilling slot raises can maximise output and minimise risks, without compromising productivity," says Salo.

"Clearly, raise boring can be a productive mining method. The basic fundamentals provide a safe and simple process, which is very fitting to underground conditions." ♥

The RHINO 100 provides a new method for drilling slot raises in underground mines

standard raise-boring tools to achieve maximum cost-efficiency. The tools, including the cemented carbide buttons, are optimised for high-rate penetration and long service life. The cutters are installed on a reaming head customised for this specific application.

The reaming head is made of forged and accurately machined high-alloy tool steel, allowing for change of distance between the pilot bit and the reaming head. As a part of its quick setup characteristics, rod handling on the RHINO 100 is optimised by including a crane and a manipulator, controlled either with a wireless remote controller or from the operating cabin.

The 21 holes required for opening a drop raise in each stope will now be replaced by larger raise-bored slot holes using the RHINO 100.

The new process at Kittilä started from scratch. None of the operators had any previous experience with raise boring. Starting from its commissioning in July 2014, only one stope and 105 drilled metres were achieved in the first month – very much at

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