Sonic drilling: not so niche

Boart Longyear describes the technology behind its LS600 sonic-drilling rig and how it is finding new applications within the mining industry

Sonic-drilling technology is gaining traction in the mining-industry thanks to its multiple uses and suitability to various ground conditions. Boart Longyear has been an expert in sonic-drilling technology for more than 20 years and the LS600 sonic rig is its latest model.

"In the past, the geotechnical/geoconstruction and environmental investigation markets have driven the demand for sonic-drill rigs," says Justin Warren, senior product manager at Boart Longyear. "This is how the technology became popular, along with its proven work history."

However, there is also a growing demand for sonic-drill rigs in the mineral exploration sector, as drillers have become more comfortable with sonic technology through other applications, such as heap-leach pad and tailings sampling.

The ability to pre-collar a borehole with a sonic drill before diamond drilling occurs is also being adopted, especially with the need to drill deeper as available minerals become scarcer.

Sonic drilling allows the recovery of 100% intact core samples

HOW DOES IT WORK?

Sonic drilling differs from conventional methods because it lessens the friction between the ground formation and the drilling equipment. Conventional drilling uses a combination of torque and thrust to cut into the ground, allowing the drill string to advance the borehole, whereas sonic technology creates a resonant energy that matches the ground conditions. This eases the friction and causes the ground formations to displace, shear, or fracture (depending on the type of formation), which allows the drill string to advance.

The resonant energy is generated through an oscillator assembly in the sonic drill head. The resonant frequency is created when two opposing elements rotate against the drill string. This causes the energy to travel down the drill string to the sonic bit.

The key gauges on the sonic rig are the oscillation and the feed pressure. The oscillation measures the vibration of the drill string in the hole. The driller will constantly adjust the resonant energy between 50Hz and 150Hz. This varies because of the ground conditions and the length of the drill string. As the borehole gets deeper, the drill string becomes longer, which affects the strength of the vibrations.

"With sonic technology, having the right resonance is important," says Warren. "The driller must match the vibration of the drill string with the resonance of the ground formation they are trying to penetrate to achieve maximum results."

Because sonic drilling is typically performed with dual casings, 100% in-situ core samples can be achieved. The drill string advances into the ground formation and, once in place, the outer casing can be advanced. This protects the integrity of the borehole. The core is then retrieved via the core barrel. Once the sample is removed, the process of drill-string advancement and retrieval is repeated.

ADVANCED TECHNOLOGY

Boart Longyear suggests the LS600 sonic rig to companies looking to add diversity to their fleet. It delivers more accurate core sampling, less than 1% hole deviation, reduced waste and faster penetration than conventional drilling methods, the company says.

"The LS600 delivers advanced sonic technology, which allows drillers to gather continuous and undisturbed core samples in varying and difficult ground formations," says Warren. "The LS600 is an efficient rig to add to a fleet and offers multiple uses for the driller."

Compared with conventional methods, drillers can gather accurate core samples twice as fast with sonic technology and reduce waste by up to 80%, because no fluid, air or mud is needed. The LS600 can reach a drilling depth of up to 182m.

The capability of the LS600 to continuously case the borehole makes it possible to install multiple monitoring wells within each hole to accurately sample and monitor specific aquifers for contaminants at various depths. Since the borehole is completely sealed, cross-contamination is mitigated.

Another use for the LS600 sonic rig is pre-collaring during diamond drilling. Drillers can avoid using diamond bits at the beginning of the hole by allowing the LS600 to advance through the early stages. Pre-collaring also provides a detailed continuous overburden sample. Once bedrock is reached, diamond drills can be used for mineral exploration purposes, saving bit life and increasing efficiency.

HEAP-LEACH PAD

As the value of minerals continues to rise, many mining companies are revisiting their heap-leach pads. As a result, Boart Longyear Drilling Services has been contracted to use its TRUSONIC sonic programme to sample and install wells at numerous, targeted heap-leach pads.

Heap-leach pads are large piles of waste rock from a mining operation that receive further processing through a leaching solution to remove the ore. The leaching solution is applied via an irrigation or sprinkler system to the top of the heap-leach pad. The solution penetrates the heap-leach pad and separates the mineral ore from the waste rock. At the bottom of the heap-leach pad is an impermeable liner that is angled to allow the solution to be collected in a reservoir and then sent for further processing.

Leach pads are made up mostly of unconsolidated material and the LS600 has proven effective in these conditions by producing 100% accurate in-situ core samples. The rig can also be used to install wells in the heap-leach pad. ►

"Compared with conventional methods, drillers can gather accurate core samples twice as fast with sonic technology"

In 2010, Boart Longyear began a contract to sample and install solution wells for the largest gold heap-leach pad in the US, located in northwest Nevada. The heap-leach pad is over 120m high. To achieve that height, the mine built up the heap-leach pad via 15m lifts.

When constructing each level, the haulers unavoidably crush and compress the previous top layer of the pad while adding material to the top of the pile. This creates a dense layer that causes a dam effect and does not allow the leaching solution to penetrate through the heap-leach pad properly. The heap-leach pad can then develop dry pockets where no leaching activity takes place – lowering the efficiency and return on investment.

Boart Longyear was hired to detect dry zones in the leach pad and to reactivate the zones via solution enhancement wells. First, the TRUSONIC team drilled test holes to determine the depths of the dry zones and the specific lithological information.

These boreholes were 107m deep and were located 15-23m above the heap-leach pad liner. A continuous core sample was obtained by using the LS600 sonic rig.

This allowed the TRUSONIC team to determine moisture concentration at accurate depths and to identify exposed ore.

Once the depths of the ore and moisture levels of the dry zones were determined, Boart installed solution-enhancement wells using an 11.5cm flush-threaded well casing. The casings allowed the borehole to stay intact as an upper and lower K-packer were installed at specific depths (*see diagram, right*). A 30.5m injection screen was placed between the K-packers to direct the leaching solution into targeted dry zones.

This process was repeated on an eight-week cycle of four weeks of solution and four weeks of rest. Once the cycle was completed, the K-packers and screen were moved to a new depth. The well received the solution at three heights spanning 30.5m each time — bottom, middle and top.

Over a three-year period, the TRUSONIC team, using the LS600 sonic rig, have drilled 55 gravity flow solution wells to alleviate the fine unprocessed gold from the heap-leach pad. This has resulted in the liberation of 6,100oz of gold that equates to an extra US$8 million profit ($1,300/oz). The client paid for the project within the first 70 days and received a 400% internal rate of return, Boart says.

The LS600 sonic rig. Below: drill holes and packing depths