Explorers get busy

With exploration activity and budgets seemingly on the rise, drilling contractors and equipment manufacturers are working on positioning themselves to accommodate the growing demand. Nia Kajastie looks at methods and technologies in use on today's exploration sites

As miners are starting to spend on exploration once again, drillers' fleets will be seeing a lot more action and manufacturers will need to have the right rigs and equipment at hand.

According to a recent report from S&P Global Market Intelligence, exploration budgets rose more than 14% year on year to US$7.95 billion in 2017 – the first increase in the annual global nonferrous exploration budget since 2012 – and budgets are expected to rise again in 2018.

"Guidance from stockbrokers and investors has been more optimistic, and exploration budgets for the near-future programmes have increased," confirms Kelvin Brown, global product manager for drilling solutions at Reflex (forming part of Imdex).

Brian Rudd, executive director of Capital Drilling, says the drilling company has witnessed an increase in exploration activity, particularly within its main continent of operation, Africa – with West Africa the most active.

"I also believe it will be some time until we see activity increase enough to allow pricing for drilling services to increase to the level they should be as a result of years of under-investment by some mining companies and a surplus of rigs still in the market," he clarifies.

Quentin Dulake, sales director at drill rig manufacturer Dando Drilling International, adds: "There's clear growth, and this is evident in the number of mineral exploration enquiries we are receiving."

He believes that the market has changed, however, with some of its mainstream competitors choosing cheaper manufacturing locations such as India or China.

"So, more than ever the focus on smart design, appropriate manufacturing techniques and selection of premium quality components is key to Dando's competitive strategy, along with maintaining the flexibility to meet the clients' specific needs."

CHOICE OF METHOD

Before delving into the latest equipment developments, let's take a quick look at the drilling methods currently in use on exploration sites.

The chosen drilling method

Site setup tips

There are many steps involved in preparing and setting up a mineral-exploration site, many of which depend on the project, location, client preferences and the objectives of the drilling programme.

Site preparation is important to ensure a clear working area, with minimal environmental impact. While many sites will vary according to the different types of exploration drilling, it is important for a safe workplace that the site is free of obstacles and allows enough space for the various supporting equipment, as well as the rig.

Access, and the type and size of rig chosen to suit this, will subsequently affect several other decisions.

Tools, consumables and ancillaries will need to be readied on site.

Once the equipment and transportation options are determined, a cascade of further decisions must be made. Safety and risk assessments need to be carried out for the site and involve both an assessment of the location and of the drilling method being employed.

Other consumables can be an issue. If access is difficult, then large rigs with big compressors that are thirsty on diesel may not be appropriate as continuous resupply might not be feasible. An assessment of the geology will be required to determine the type and amount of consumable items such as drill bits. This is particularly important for a contractor as it affects their bottom line. Required meterage and drilling performance, especially where these are specified in a drilling contract, will also affect equipment choices.

These are all decisions that need to be made prior to physically preparing the site. A stable drill pad for the chosen rig can then be constructed, equipment laid out in a manner that provides for safe, efficient drilling, and which also fits the size and shape of the location, and drilling can begin.

obviously depends on what the geologist is trying to accomplish, as well as the information available on the area.

"If they know a lot about the ground, they'll likely choose reverse circulation (RC) drilling," says Robert Jex, Boart Longyear's operations manager for coring in the US.

"To accomplish drilling project objectives within budget, RC drilling offers a cost-effective drilling method for assaying chip samples and obtaining preliminary geological data prior to investing in detailed geological data from an exploration coring programme. RC is also faster, which means accomplishing more exploration."

Accordingly, the method remains very popular, both with down-the-hole (DTH) hammers in harder geologies and aircore bits in softer ones. However, if you require more information from the hole, the choice often falls on core drilling.

"A quality core sample is the best indicator to show you exactly what's below the surface and what mineralisation you have down the hole," says Rudd, adding: "While RC drilling is cheaper than diamond drilling, the rig footprint on site and mobilisation costs are generally higher than the smaller diamond rigs, which also enable clients to access more remote areas."

Jex adds: "Diamond coring is probably the most common form of drilling, because it provides a relatively large, intact sample for both stratigraphic and mineral analysis.

"Core orientation provides another level of detailed information on system geometry, potential plunge components and the orientation of potential faults that could offset mineralisation. But most of all, it provides the context for other data sets, which allow for a better interpretation of geochemistry, mineralogy, short-wave infrared (SWIR) and geophysical data."

Dando mineral exploration rigs are multifunctional machines, so many of its customers will alternate between RC and wireline coring.

"For many projects wireline coring strikes an acceptable balance between retrieving a relatively undisturbed sample, accurate depth data and penetration rate," Dulake explains.

"The majority of our Multitec 4000 and 9000 rigs supplied to customers for exploration are used for wireline coring at least some of the time. Although the N, H and P standards are prominent, there seems to be a recent resurgence in Geobore S coring, especially in difficult geologies where excellent recovery and a large, 100mm core is required.

"Triple-tube wireline coring is also favoured in some geologies. The majority of exploration drilling customers in Indonesia, for example, select H or P-WL3 setups with split inner tubes."

Air-flush or rotary air blast (RAB) drilling methods are also used for certain requirements.

"Prospectors looking to prove a resource may use RAB to quickly explore a new concession," says Tom Way, who covers Southeast Asia sales for Dando. "What air-flush drilling lacks in terms of contamination from the borehole, it gains in speed and low cost."

Exploration teams at coal mines in Kalimantan, Indonesia, for example, are achieving 350m a day using open-hole air-flush drilling with Dando Mintec 12.8 rigs.

Meanwhile, in the jungles of the Democratic Republic of the Congo, a team prospecting for gold has been RAB drilling at angles up to 45° with Dando's smallest rotary rig, the Dando Terrier, to depths of 50m to prove a gold resource. "This method provides enough information to indicate whether the area should be revisited later with a drilling method that can provide more detailed data," Way notes.

Sonic drilling is known as a method that provides a continuous, relatively undisturbed in-situ core sample in soft or broken ground – it is best used for lithium and tailings pile testing.

The open spaces and many clear tracks on this concession in the DRC led Kamoa Copper to choose a Multitec 9000 mounted on a 4x4 Iveco truck. With an 1,100rpm top-drive head, this rig has the performance of a dedicated chuck-drive rig, but the versatility, safety and strength of a modern top-drive

"Sonic drilling offers many advantages, but the main disadvantage is the depth capability, which is relatively shallow (244m or 800ft) when compared with the capabilities of RC and diamond core drilling (just over 4,000m or 13,000ft)," Jex says.

SAMPLE QUALITY

When it comes to mineral exploration drilling, it's not only about the metres drilled, but about delivering a quality sample to the client.

"An exploration hole isn't like a water bore, where the client is only interested in the completed hole," Rudd points out.

"Mining companies and their geologists are paying us to deliver a high-quality, clean box of core, and ideally, 100% of the core must be recovered from the drill hole. Similarly with RC and grade-control drilling, clients need an uncontaminated, correctly split sample. After all, they make a lot of important and often expensive decisions based on this information." ►

These nickel laterite-bearing formations are challenging to sample. Dando supplies its Destroyer triple-tube wireline equipment with a selection of bits to maximise recovery

The right kind of sample is the one that meets the requirements of the exploration programme.

"For example, early exploration of a new prospect may only require confirmation that a resource exists. In this instance a quick, low-cost air-flush chip-sample may be exactly what is needed to secure funding for a large-scale coring endeavour aiming to provide more detailed data," Dulake says.

Core sample quality is greatly affected by ground conditions such as unconsolidated materials, highly fractured formations, soft ground, broken ground, cavities or voids.

One of Dando's customers prospecting for gold in flowing mineral sands was limited for options due to the difficulties of this geology. They chose the Dando Terrier rig using the percussive mast and simultaneous Duplex casing and sampling, and, Dulake says, they achieved fantastic recovery, drilling up to two 15-20m boreholes a day.

Rotary coring was not possible in this geology, and other suitable methods such as sonic drilling were prohibitively expensive for this early stage in the project.

The hammer-driven tubes retain sample inside plastic liners, which can be capped and sent directly to the lab for maximum preservation.

Jex adds: "A high-quality sample from exploration drilling is relatively intact for better analysis and 97%+ core recovery rate."

Improving core recovery can be accomplished with high-quality tooling, and selecting specific tooling such as larger diamond barrels, various flushing mediums (mud) and triple-tube barrels.

Having predictable, trustworthy equipment allows the driller to make careful adjustments to achieve the desired sample – without consistency this isn't possible.

Dando Terrier percussive samples are presented in a clear plastic liner. With a variety of basket catcher designs to prevent sample loss, this rig has been sampling mineral sands successfully from 10-20m

ADVANCES IN TECH

From automated equipment to real-time data collection, exploration technology has seen some changes and innovations over recent years.

Among other things, a lot of effort has gone into improving the safety features on new rigs and incorporating these upgrades into older rigs where possible, while removing people from harmful exposure and increasing productivity and quality.

"A major focus has been the removal of manual handing of drill rods and eliminating the need for tools while drilling through the installation of rod spinners and rod-handling devices," says Rudd.

Moving and rotating parts on rigs constitute hazards, but there have been considerable advances in this area.

"Dando rigs follow strict UK and European safety standards, and rotating parts are guarded," explains Dulake. "Many of our exploration rigs feature immediate rotation speed reduction when the mast-foot cages are opened. Dando's rod loaders are also fitted with proximity sensors,

which immediately halt operation if a body is detected in the vicinity."

He continues on the topic of exploration game-changers: "I think it's impossible to discount the incredible advances in top-drive rotary head performance over the last few years. These advances are slowly making other rotation methods redundant."

Dando recently supplied Kamoa Copper in the Democratic Republic of the Congo with a Multitec 9000 with a top-drive head and rotation speeds up to 1,100rpm. This allows it to carry out its coring work with P, H and N equipment to 550m and achieve penetration rates that previously would have only been possible with chuck drive heads, while retaining the flexibility to carry out other key methods such as RC and RAB if required.

Dando has also focused heavily on manufacturing smaller, more powerful rigs. This decision has been largely market-driven with both financial and environmental factors playing a role. The downturn in exploration over the last few years has reduced budgets available for exploration programmes, so customers have been looking for solutions with lower capital expenditure, running and maintenance costs.

Drilling rig manufacturer Schramm expects the mining market to really pick up in 2018, globally, and aims to support its customers with new products, while also ramping up capacity for new rig builds and service support. Recently it has witnessed a real push for increased RC drilling.

As a result, it has taken its older T450GT rig (with 30,000lbs/13.6t pullback) and incorporated the 40,000lb T455WS mast to create the T455GT. "This extra 30% in capacity has really proven to be popular, with much of the exploration needs getting deeper," Craig Mayman, Schramm's vice-president of sales and aftermarket, says.

"We also took advantage of this exercise to ensure it has our latest hands-free rod-handling technologies, incorporating the KL-style rod handler and Metzke dual break-out system.

"This new configuration has proven to be our most popular rig in the last 6-12 months."

About 18 months ago, Schramm launched the Fury series of rigs at MINExpo in Las Vegas, Nevada, US.

"The first version was spec'd to suit larger water-well and mine-site dewatering projects," he explains. "We are now completing the mining spec, and this includes 130,000lbs pullback mast with sliding angle capability – again answering the market's needs for deeper drilling (vs our old 90,000lbs on the T685). A unique feature of this angle mast is a completely hands-free locking system."

Manging and analysing geological data analysis in real time is at the forefront of many explorers' minds, and new solutions have been created to assist them in their decision-making.

Boart Longyear, for one, is launching a new technology called TruScan for elemental and photo scanning of core at the exploration site, thus providing geologists access to near real-time geological data as the core is drilled.

Utilising XRF technology specifically built to scan rock, TruScan is designed to provide same-day continuous analysis of the drill core and quickly provide non-destructive, accurate, high-density elemental concentration data. In addition, TruScan offers high-definition wet, dry and scan-spot photos (to scale) of the retrieved rock core. This information can be quickly viewed by the geologist and aids in the logging and interpretation of the geology – more accurate conceptual geological models can be built while the drill is still on the borehole.

"Because the time to collect data is significantly reduced, exploration and mining companies can make accurate and timely decisions on where to drill next or to what depth, thus lowering the costs of collecting and analysing data," explains Jex.

"While traditional lab assay techniques and portable x-ray fluorescence (pXRF) devices have been available to mining clients for some time, there are limitations to these technologies. Lab analytical techniques often come with time delays and costs associated with sample processing, shipping and analysis. Many handheld pXRF devices available today use fundamental parameters, which can be inaccurate due to limitations in calibration."

TruScan uses a unique XRF technology to address textural variations in rock and site-specific calibrations to address the rock type-specific matrix effect. To ensure more precise on-site readings, rock samples are sent first from the site to the lab for chemical analysis. Once received back, the resulting chemistry is used to calibrate TruScan's XRF technology, which is performed by a qualified Boart Longyear geochemist prior to the unit being sent to the drill site.

Because it has been previously calibrated, TruScan does not require the operator to have knowledge of XRF analysis. ►

Site rehabilitation tips

A drill crew should always strive to leave minimal impact to the environment as the drill site is packed up. Drilled holes should be abandoned in accordance with government regulations, which typically include sealing the top portion of the hole with a specified length of a cement plug. The site should also be cleaned up, graded and seeded with local vegetation.

Prevention is the first step to successful rehabilitation. Best practices that are proceduralised and adhered to by the entire drill team reduce the amount of clean up following drilling. Basic common-sense practices, such as using catchment trays when refuelling or changing hydraulic filters, should be standard for everyone working on the rig.

Polymers and other drilling fluids have developed and there are a number of biodegradable options available (in the Dando range, for example). Most regions of the world now have their own regulations and specify what can be used and how. This needs careful planning for prior to drilling.

Another way to ensure sites are rehabilitated to their original state is to take photos that capture the site condition prior to clearing beginning, and again once the rigs are set up and sumps completed. Once the hole is completed, it should be capped so animals (including snakes and other smaller animals) do not enter the hole, but allow it to remain intact if logging is required at a later date.

Once all equipment is removed, the entire site should be raked and the sump pumped out, with fluid transported to a designated disposal area. If centrifuges are used during drilling operations, however, the disposal of water and cuttings, as well as back-filling of sumps, is minimal and the site footprint is smaller, minimising environmental impact and required rehabilitation.

TruScan can be operated by the drill crew, removing the need for additional staff on site.

Moreover, the introduction and use of more advanced digital sensor technology over the past five to 10 years has delivered faster data acquisition at a higher quality.

Brown says: "Key products that use digital sensors are north-seeking gyros such as the Reflex EZ-GYRO and the Reflex TN14, a rig-alignment tool that uses digital sensor technology to align your drill rig, significantly reducing the time to accurately set up the rig.

"Another product that has changed exploration practices is the advanced digital core orientation system – the Reflex ACT 3.5. The digital core orientation system records the orientation of the core sample and other key data in core drilling operations. Its high level of data accuracy leads to better understanding of the geological structure, ultimately resulting in enhanced drill programme management and geotechnical planning."

He adds: "One of the biggest advancements is the need for real-time accurate QA/QC data, and with Reflex tools the ability to sync data from your field tools through the cloud-based IMDEX-HUB-IQ in near real-time is now a reality, making this data available between the field and office."

Rudd agrees that data capture and real-time data sharing will lead the way in improving performance, training and efficiency of the industry.

"A good example is the IRIS health and safety surveillance system we have recently been installing on several of our rigs," he says.

"The system uses a number of cameras strategically mounted around the rig and drill shack to show complete visibility of the work area. The data is held on board the rig, but can also be accessed from the server via a mobile app in real time, from anywhere in the world where the connections are available."

Capital is also introducing the Gyrosmart Compass. This enables drill-hole co-ordinates to be entered directly into a handheld unit on site or pre-loaded from any location worldwide and sent directly to the rig. Drill-hole alignment data is transferred back to the geologists and maintained on a database, which can then be accessed for audit and other needs. The unit improves rig alignment, removes mistakes caused by human error and reduces cost by removing the need for surveyors and the wait time while surveyors align the drill.

Wellforce International (WFI), in turn, has developed unique software that shows a 3-D view of the borehole path below the surface – if required it can also provide a report to get your hole back on target, and you can plan multiple targets from the one hole. This software can help with more efficient borehole management and ensure the target is hit on every hole.

Overall, the industry is starting to recognise the benefits of these time-saving technologies and systems that improve the efficiency of data transfer and knowledge sharing for more accurate exploration.