Clear cut choice

Diamond core drill rigs are a valuable, long-term investment for mineral exploration companies. *MM* spoke to six of the world's top manufacturers on what to look for when selecting a rig

Many drilling techniques can be used to obtain samples for analysis in mineral exploration applications, including: diamond core; reverse circulation (RC); rotary air blast (RAB); air blast; and sonic drilling. All of these methods have benefits and pitfalls depending on the specific results that need to be achieved. No single drilling system or sampling method works best for all drilling conditions – rock formations are rarely homogenous and may change significantly, even in the same borehole.

When selecting a sampling method, it is important to consider the following parameters:

- Borehole size and depth;
- The type and quality of the sample that needs to be recovered;
- Whether the site is brownfield or greenfield; and
- Leases and budgets.

Eric Paquet, product manager - drill rigs at Fordia, says: "While diamond core drilling is sometimes more costly than other techniques, it is the only method that can collect consistent, high-quality core samples along the entire length of a borehole." This allows for accurate interpretation of the structural geology when logging, and a high degree of clarity in assays and other methods of lab analysis.

While RC drilling offers rapid execution, and similar or less expensive operating costs, the samples collected via this method can be less precise.

RC drilling is ideal for quickly extracting core chips at shallow target depths, whereas diamond coring is more reliable when precise samples and structural information are required. Rock fragments obtained using RC drilling can also be misinterpreted, as they often get mixed up with chips from different depths during drilling. The sample can thus be contaminated and may distort analysis results.

Wayne Slight, global market and sales support manager for exploration drills at Sandvik, explains: "RAB and RC drilling methods retrieve an accurate, representative chip sample of the rock, and are appropriate drilling methods in first-pass and infill drilling, intermediate, delineate orebody and grade-control programmes, but will offer no information on the structural or physical properties of the geology.

"Diamond core drilling is better suited to intermediate- and late-stage exploration, reserve-definition and structural control drilling programmes. Core drilling will retrieve a highly accurate, solid, cylindrical sample from the rock, down to depths of 4,000m."

A key advantage of diamond core drilling is the one-pass technique. It gathers the highest quantity of information in one bore, from top to bottom of the borehole. Justin Warren, senior global product manager, drilling equipment at Boart Longyear, adds: "Another advantage of the diamond drilling method over RC or RAB is that it allows 3-D assessment of the lateral extent and depth of an orebody."

For exploration projects in remote or environmentally sensitive locations, the use of diamond rigs is also preferable owing to their portable nature: many are constructed in lightweight modules to allow easy transport and fast assembly. Diamond core is also the preferred sample method for JORC compliance, and as known mineral resources dwindle, exploration will move increasingly towards portable, yet deep-capacity rigs, to search for new reserves.

RIG TYPES

Although many different styles of diamond coring drills exist, the components are essentially the same, apart from the mechanism that drives or rotates the drill string in the hole. Mr Slight explains: "The two most commonly used mechanisms are top-drive rotation units and hollow spindle rotation units. A top-drive rotation unit is usually a component of a multi-purpose rig which easily can be adapted for core, DTH (down-the-hole) and RC drilling.

A Hydracore drill rig in operation in Guatemala

"A hollow spindle rotation unit is a component of a dedicated core drill, which is available with a drill mast for longer pulls or, as a smaller, modular version with a feed frame that can be used for both surface and underground applications. The advantages of using this type of rotation unit are that they can operate with a shorter mast and feed cylinder. This is because the unit can drill down, stop and move up to the top of the rod and continue drilling again, resulting in an average 3-4m stroke instead of the 6m stroke required for most top-drive units.

"The hollow spindle also makes use of chuck jaws to grip the outside of the drill rods, which reduces rod wear, as less torque and feed force is applied to the drill string. This type of rotation unit can also be used to assist with the making-up and breaking-out of the rod joint. Drills using hollow spindle rotation units tend to have a much smaller profile, which is why the majority of underground drill rigs are this style."

As a leading global ►

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The LF90 is one of a range of Boart Longyear's rigs that provides different depth capacities

The Golden Bear rig from Fordia which offers a range of customised options, including motors adapted for high altitudes

manufacturer of multipurpose drills, Sandvik has a strong bond to this type of rig. However, the company has reported that its best-selling rig for surface exploration applications is the DE710 diamond core rig. This is a compact model designed for tough conditions and has a strong meterage strike rate. It is used largely in Latin America and Africa in mountainous areas, where its size and small footprint are compatible with the terrain. For underground use, Sandvik's DE130 and DE140 prove to be its most popular models. The compact, modular design enables them to move in tight spaces with minimum disturbance.

PURCHASING CRITERIA

Buying a new drill rig represents a significant capital investment, even for very large companies. The selection will ultimately affect the productivity and profitability of its drilling projects, and is entirely dependent on the nature of the drilling to be undertaken.

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Dawn Overby, vice president of sales and marketing at Ingetrol, highlights: "The first thing that needs to be defined is how deep the drill needs to penetrate and the diameter core size required by the geologist. This information will determine the size of the rig."

The drilling capacity of a rig and how it compares with the customers' requirements is probably the most vital consideration when making a purchase; there is little point in spending a large amount of money buying an extremely powerful machine if the company only requires a drilling capacity of a few hundred metres. On the other hand, no drilling contractor wants to turn down a contract because its equipment does not meet the technical requirements.

Mr Warren says: "Depth capacity is one of the most important criteria in selection of most diamond drills, as the rig needs to be capable of reaching the depths required of the drilling programme. There are several parameters affecting the depth capacity of the drill, including pullback force, the holding force of chuck and footclamp, the hoist capacity of the winch and the torque and RPM generated by the rotation unit. Different models such as Boart Longyear's LF70, LF90 and LF230 provide different depth capacities to meet these requirements."

Ingetrol's Explorer Jr 36D2 rig

It is vital to consider the size of the work area in relation to the size of a drill before purchase. Mr Slight says: "Trying to mobilise a large rig in a tight spot can create severe problems, and getting the rig into the correct position would be very difficult. A rig that is too small for the programme could mean having to move a larger rig onto site at a later stage. With the sumps and drill pad established, this can cause long down times and delays."

Ms Overby adds: "Ingetrol continues to focus providing drill rig solutions for deeper holes while maintaining portability. Ingetrol relaunched its Explorer Plus MD4 drill rig in February, increasing its drilling capacity to 900m in NWL and 600m in HWL, while maintaining the maximum modular weight at only 245kg. The size of the rig and operating site will also determine access to water carriers, and can create issues with rod handling and rig maintenance."

Mr Paquet adds: "Because the current trend is to drill increasingly deep holes, with increasingly large diameters, more and more companies are looking for very high-capacity drills with a rotating head that can accommodate diameters up to PWL."

It is also important to define whether the rig will be used for surface or underground drilling. Some drills can be adapted to operate in either environment, and many manufacturers offer a conversion kit for their rigs.

Mr Paquet comments: "Fordia offers an optional conversion kit for all of the surface models in its new Eider line of drills. So a company can choose to invest in a conversion kit rather than buy a whole new underground drill. We have found that this flexibility is greatly appreciated particularly by small- to medium-size drilling companies." The Eider range has recently been updated with new features such as two hydraulic pumps for a greater and independent hydraulic pressure control, and a number of other options allow the drills to be customised to meet customers' needs.

Ease of transportation is another key concern for customers. This is particularly important when operating in remote or high-altitude areas. The weight of each piece of equipment has a direct impact on the cost of transport, which, in such cases, is often undertaken exclusively by helicopter.

Ms Overby supports this: "It is important to consider how the drill will be transported. How remote is the location? What access routes and infrastructure are available to reach the site? This will determine the level of mobility that the rig requires and how it can be moved to the site. Then you can decide if the drill will need to be man-portable, heliportable, mounted on skids, a truck or crawler tracks.

"If the drill will be working at high altitude, that is over 3,000m above sea level, this must be taken into consideration when choosing a diamond core drill rig, as the motor's maximum potential will be reduced by as much as 30% in high altitude. To compensate for the high altitude, it is recommendable to use a turbo-diesel motor, as well as increase the horsepower of the motor."

Mr Warren adds: "Having adequate power to drill the hole is necessary to compensate for geology of the rock during drilling. A high torque:rpm ratio is directly proportional to the power of the drill. A higher torque is needed for

Drilling operations with Hydracore

efficient drilling in fractured ground conditions, while higher rpm is needed to drill the hole faster in competent ground conditions. Boart Longyear's LF Series surface drill rigs have a high-torque rotary head compared to the underground LM series drills, which helps the driller compensate for the broken ground conditions which can be encountered in surface drilling applications."

Companies wishing to add a drill to their fleet should also consider all of the configurations and optional components available on purchase. Many manufacturers can customise rigs to meet specific requirements, while some even have a dedicated technical team offering advice when choosing optional extras. For example, Fordia offers motors adapted for high altitudes; shacks and heating systems for drills operating in extremely cold conditions; additional safety guards to meet varying safety standards; and can repaint rigs in clients' corporate colours. Boart Longyear offers a similar service. The RC rod handlers on its LX16 and LC36 drills eliminate the process of manually adding and removing the rods from the drill, and incorporate safety features such as interlocked rotation barriers and synchronised chucks.

MAINTENANCE AND REPAIR

Maintaining and repairing a drill can be highly complex, especially when operating in remote areas. To ensure the success of and profitability of the drill programme, and to enable its completion within the allotted time, the onsite team must ensure that they have access to a full inventory of spare parts and repair tools.

Wear parts must be checked regularly and the company should promote equipment use that respects the clauses stated in the rig's manufacturer warranty. This will help to optimise the equipment's functionalities while also ensuring normal wear.

Mr Slight says: "A strong understanding of the drill that you are working with is paramount. With this understanding, and training and support from the OEM, it is possible to implement a good maintenance programme, have the spares on hand should a fault occur, and keep down time to a minimum."

Mr Paquet says: "Some drills, like Fordia's Golden Bear 1 400 S, have a simple mechanical design that allows for the replacement of important parts without the need for a technician or hydraulic engineer."

Nigel Spaxman, manager of Hydracore, adds: "Choosing a good-quality machine that utilises a simple and straightforward design will help to avoid unnecessary maintenance problems. If a rig is operated in accordance with the manufacturers' guidelines, the major components should last at least a year before an overhaul would be required.

"Hydraulic systems on drill rigs are often much more complicated than is necessary. A load-sensing hydraulic system is not always required on a diamond drill, but most machines have them. Pumps and valves for these systems are expensive to replace and are often prone to failure. Staying away from electronically-controlled diesel engines is a good way to avoid problems too."

As with any mechanical issues, prevention is better than cure. Taking time to check the rig over before and after a shift can significantly improve the chances that it will perform optimally. Ms Overby explains: "During this time, the driller should thoroughly review the rig, looking

> **"If a rig is operated in accordance with the manufacturers' guidelines, the major components should last at least a year before an overhaul would be required"**

A cross-section of diamond core drill rigs: Boart Longyear's LF230 (below);

The Fordia Eider 1100 (right); the Ingetrol Explorer Plus MD4 (far right)

for worn parts or anything out of the ordinary. The rig should also be cleaned, well-oiled and should receive regular services at planned intervals.

"It is important for the driller to feel responsible for the rig; we have seen too many occasions when the responsibility of rig maintenance is passed from person to person and no-one takes ownership of the rig. It often leads to problems."

AVOIDING COMMON MISTAKES

Rushing to buy a rig because a tender has been won, or choosing a model based on a quick delivery time, rather than for the purpose of the project are the most common mistakes companies make when buying diamond core rigs (they are also the most expensive).

Ingetrol believes that poor identification of project requirements when

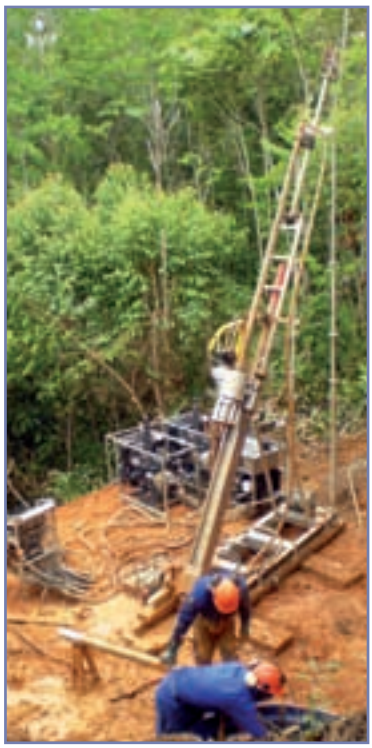
choosing a drill rig can also result in an incompatible purchase. "Many times, the person choosing the drill rig is not the person who will be using it, or even someone who will be on site when drilling is taking place," says Ms Overby.

"And they do not understand the requirements of the drilling programme thoroughly enough. The worst thing that could happen is that the drill rig gets to the site and it is unusable, or no-one wants to take responsibility for the rig, because the correct requirements were not given at the start."

Under-estimating the expense and slower drilling rates associated with diamond core drilling in comparison to RC methods can also cause a short project to become long and expensive.

It is important to assess the overall cost of running a drill rig as well as purchasing it. A spokesperson at Energold says: "Sometimes mining companies decide to purchase their own rigs because they assume it will be cheaper than hiring a contractor. However, they later discover that it is not easy to operate, maintain and provide logistics for the machine, and it can often end up costing them more in the long run."

Mr Slight adds: "Site preparation and water supply are often overlooked as well. This causes delays in getting equipment to the site to support the rig. The drill is just one piece of machinery for the driller to keep in mind. There is a total package, and the package must support the project. In short, know the programme, know the rig you choose, plan the drill, and drill to the plan."



Mr Spaxman says: "I think that a bit of thorough research on the part of the purchaser, for example, by asking other owners of the machines that you are interested in buying their opinions, and by speaking to different manufacturers on the options that they offer, would help to prevent a lot of problems. This will also give a better idea of the actual performance of each model."

Mr Warren says: "Arguably, the most important factor is to ensure that the drill is maintained in accordance with the schedule laid out in the manufacturer's operation and maintenance schedule. If the servicing steps laid out in this document are followed, the drill should give many years of reliable service and maximise drill uptime. Also ensuring daily prestart checks is an important safeguard in identifying potential problems before they cause drill down time."