

# Mineral exploration: Choosing the right core bit

Drillers' guide







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# Introduction

Choosing the right drill bit is the one decision that will have the greatest impact on your success and drilling productivity. Unfortunately, due to the many variables you must consider, it is a complex issue.

This guide will outline the steps you should take when choosing a diamond drill bit, also known as a core bit.



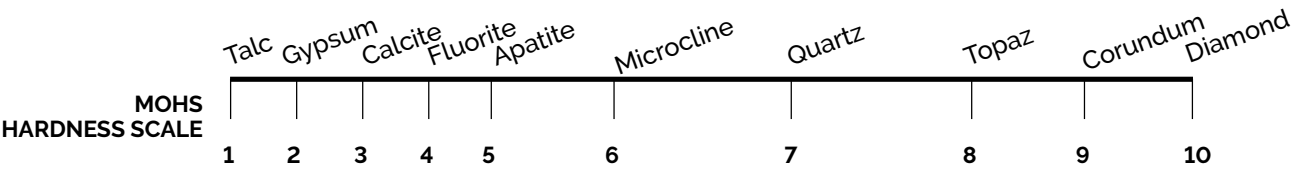
# Define hardness of rock

Let's look at one of the most important variables that will affect your choice - **ground conditions**. The type of ground is paramount in any decision regarding core bit choice. There are several factors to consider.

## Hardness

The **hardness of the ground** is measured according to Mohs Hardness scale, a chart of relative hardness of various minerals. The scale consists of numbers one through ten: 1 being the softest and 10 being the hardest. Drill matrices are developed to perform ideally within a certain range of the scale so you need to pick a bit suitable to the hardness of the ground to be drilled. There are tools available that can help you identify the hardness of the ground.

The simplest and most reliable way to determine rock hardness is to perform a scratch test using an etcher kit and compare the results with Mohs scale. If you do not have such tools, you can still determine the hardness using a pocket knife or a metal saw, although results may not be as precise.



If you are using a pocket knife, the average hardness of this tool is approximately 6.0 to 6.5 and if you are using a metal saw, it should be around 6.5 to 7.0 on Mohs scale.

To order an Epiroc etcher kit, contact your sales representative.

## Example

Mike measured an average hardness of 6.5 after performing three scratch tests on samples of his latest project. As the ground is coarse grained and slightly abrasive, his representative suggests he should choose a HERO 7, HOBIC 7AC or AZURE bit.

After a few hundred meters, Mike realizes that the penetration rate is too slow. He notices that that rock has increased in hardness and is now much more fine-grained. His representative then suggests he should use a higher number matrix and sends him a couple of HERO 9 core bits.

A week later, the new bits have proven themselves. The penetration rate has improved and Mike has reached the productivity level he was hoping for.





# Abrasive rock

This is another ground condition that can be challenging and can cause headaches among many drillers. It can be difficult to drill through when present in any hardness of ground. Abrasive rock can wear down drill bits prematurely.

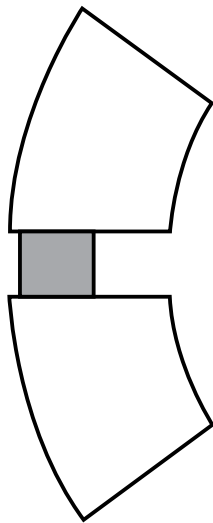
Luckily, there are core bits, such as the HERO abrasive line that have been developed specifically for abrasive ground conditions. These bits have a special matrix consisting of alloys and diamonds that when combined, are very resistant to abrasive conditions and are easy to sharpen in the hardest conditions. You should always look for waterway configurations that specifically address abrasive conditions, for example, those with wider waterways that flush out cuttings easily.



# Rock is competent or fractured?

Terrain can be either fractured or competent and each will need a different kind of drill bit. For example, a bit with a triple deep waterway configuration is ideal for fractured rock. It is designed to allow better water flow to the bit with reduced risk of eroding the core. You can learn more about configurations in our Fundamental Guide to Core Bit Configurations.

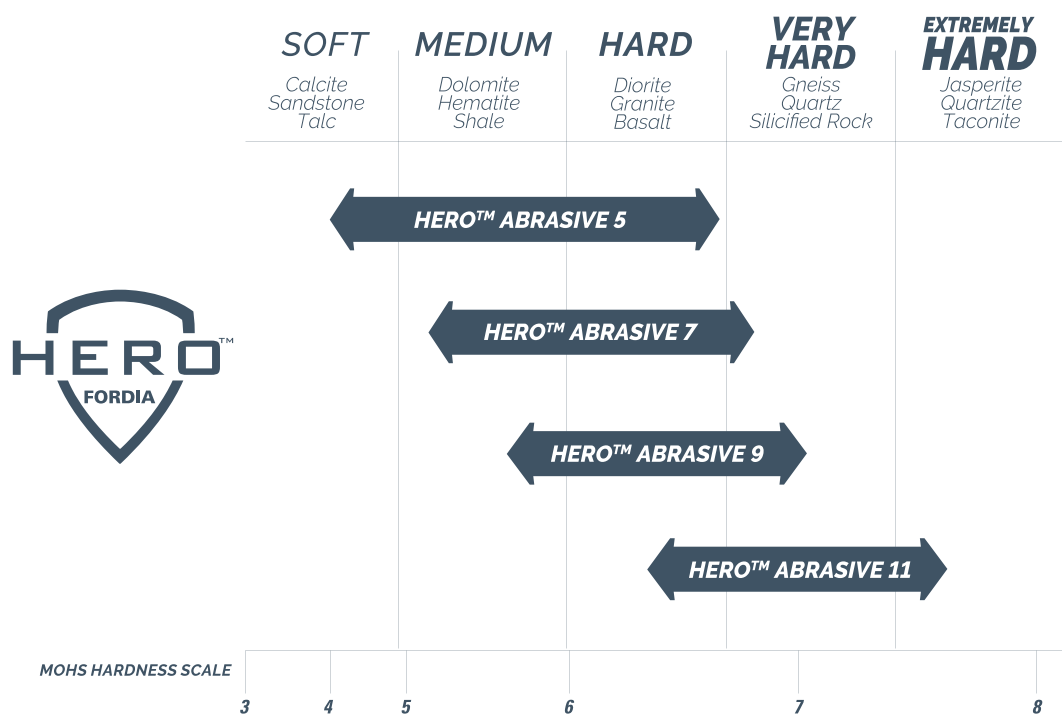
## Triple deep or sand



The lateral angle and the deeper waterways combine to provide the maximum flushing capability possible with this type of design.

This configuration is a good choice for hard and abrasive ground conditions as well as soft, broken ground. It is a very popular choice for iron ore formations.

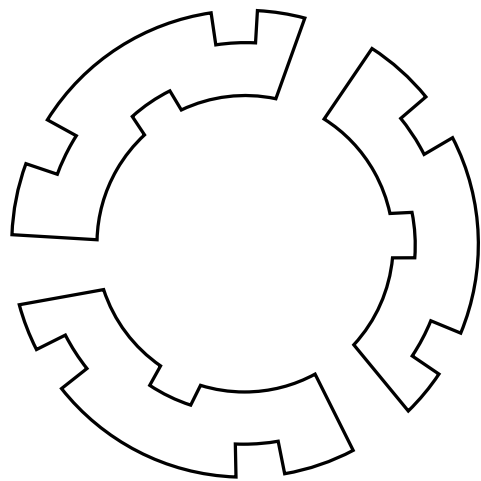
Other waterway configurations available.





# Variability of rock

Some ground is more variable. It may be soft for the first 100 meters and then become harder, or fractured. When dealing with variable ground there are many products on the market that provide the versatility needed to perform well in varying conditions, such as the VIKING™ series.



JET configuration.

For ground that is consistent, you may want to choose a bit with a higher crown, such as a Vulcan or JET configuration.



# Consider type of drill rig

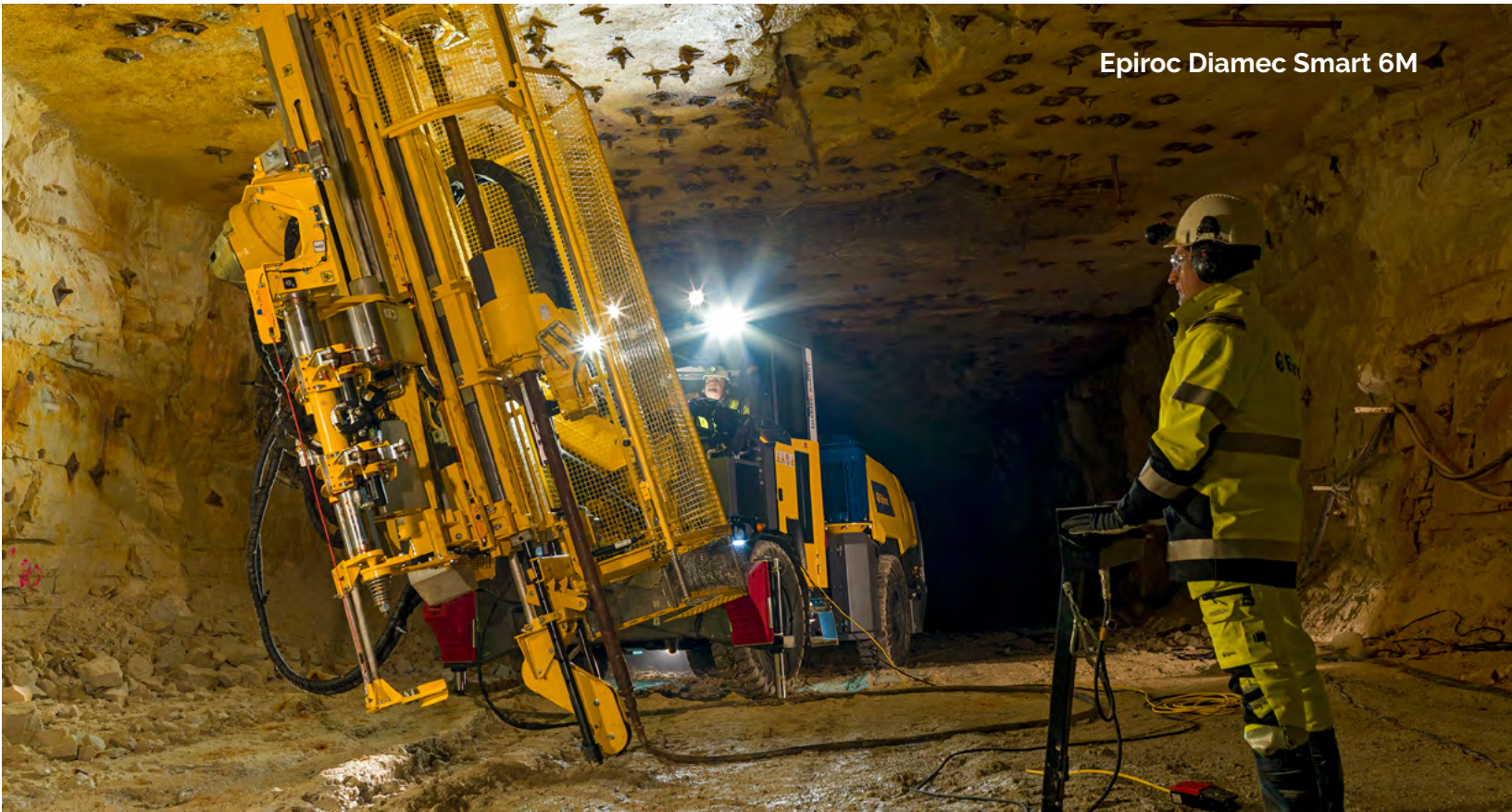
The type of drilling rig and the capacity at which it is working are both factors you should consider when choosing your drill bit. If you are using an older, gear-driven drill rig with more power and less rotation, then you should choose a bit with a standard configuration. If you are using a high powered, hydraulic drill rig capable of much higher rotation speeds but less torque, then a turbo pie-shaped configuration would be the a good choice. If you are using a lower powered, underground drill rig, then a thin-walled, turbo pie-shaped configuration should work best.

Also, it is important to consider at what capacity level your rig is working. You may find that you need to get more rotation for a particular diameter of bit but your rig is already pushing its limits.

For example, your ground may indicate that you should be using a HOBIC 7AC or a HERO 7 NO and your rig's limit is 1000 meters in NO. Once you reach 800 or 900 meters, you realize your rotation speed is starting to decrease. You need that rotation speed so your option would be to use a HOBIC 11AC or a HERO 9.

Why? In order to compensate for the lack of rotation, you would need to use a bit with a softer matrix since a softer matrix allows the diamonds to expose themselves more efficiently. Bits with a higher number, like a 9, are softer than bits with a lower number, like a 7.

Always consider changing the type of bit if you encounter issues. It is much easier to change a drill bit than to change your drill rig.

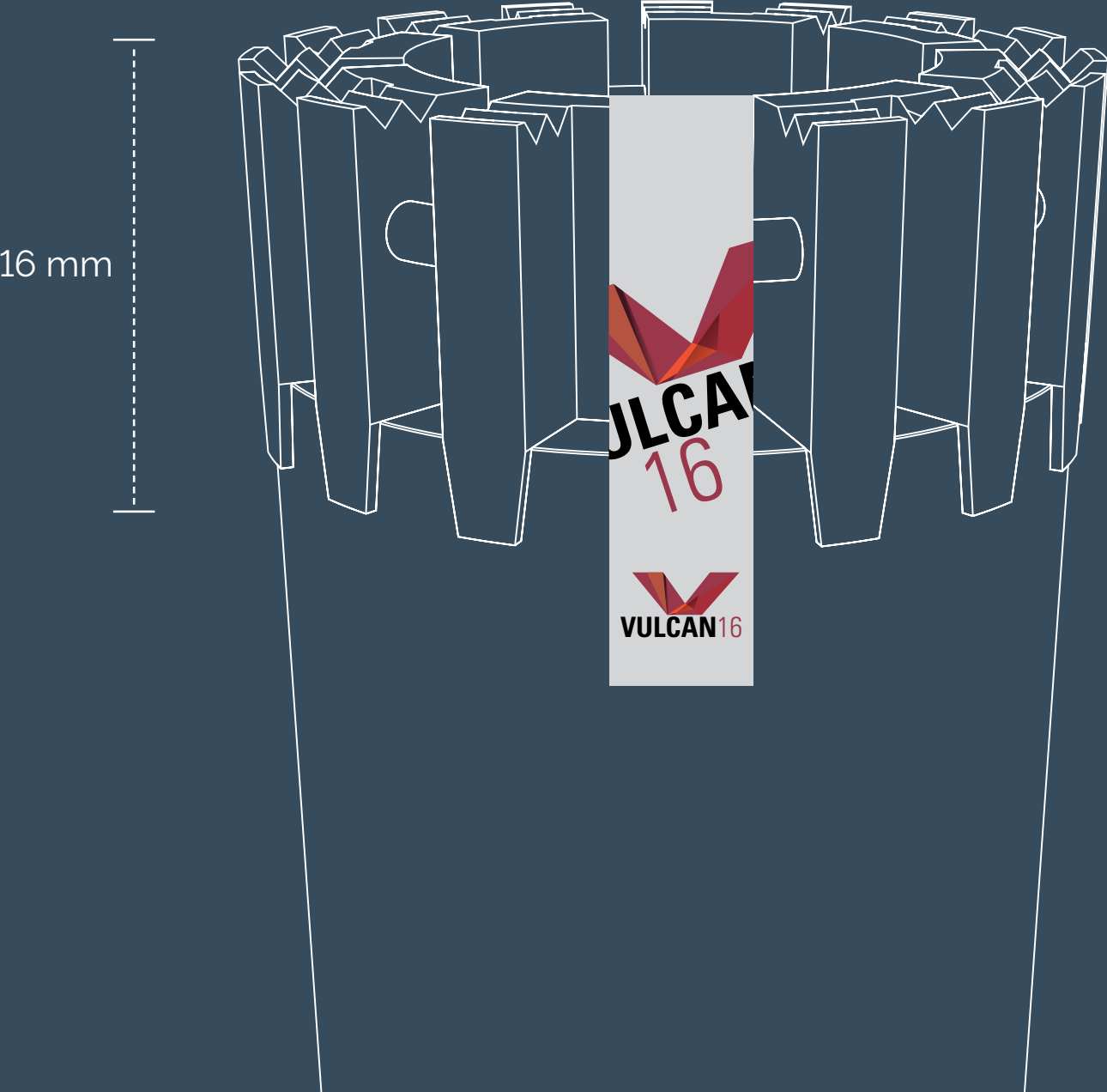




## Depth of drilling expected

The depth at which you will be drilling can play an important role in determining the impregnation depth of the crown. The term "impregnation depth" refers to the height of the matrix layer on a core bit crown that is impregnated with diamonds.

The standard size for most bits is a 13mm impregnation depth. Generally speaking, bits with a higher impregnation depth are recommended for deeper drill holes, such as core bits with a JET or a Vulcan configuration. These configurations come in 16mm, 20mm or 26mm.



## Consider level of drilling expertise

No one starts out as an expert in diamond drilling, so while you are gaining experience, you should pay attention to certain parameters. You should always refer to a drilling parameter chart to make sure the speed or rotation of your drill rod corresponds with the diameter you are using.

Refer to our guide on drilling parameters to learn more.

SIZE	RPM
AO	950-1,050
BO	850-950
NO	750-900
HO	650-750
PO	600-700

Even using this chart as a benchmark, you may have to adjust a few times before you achieve your ideal penetration rate in relation to your rotation speed.





# Consider knowledge of area

Sometimes you will be lucky enough to know in what kind of ground you will be starting a drilling operation, and sometimes it will be an unknown factor.

If possible, refer to previous drilling campaigns in the area to learn more about the ground. If it is the first time the area will be drilled, you may want to avoid using a premium bit.

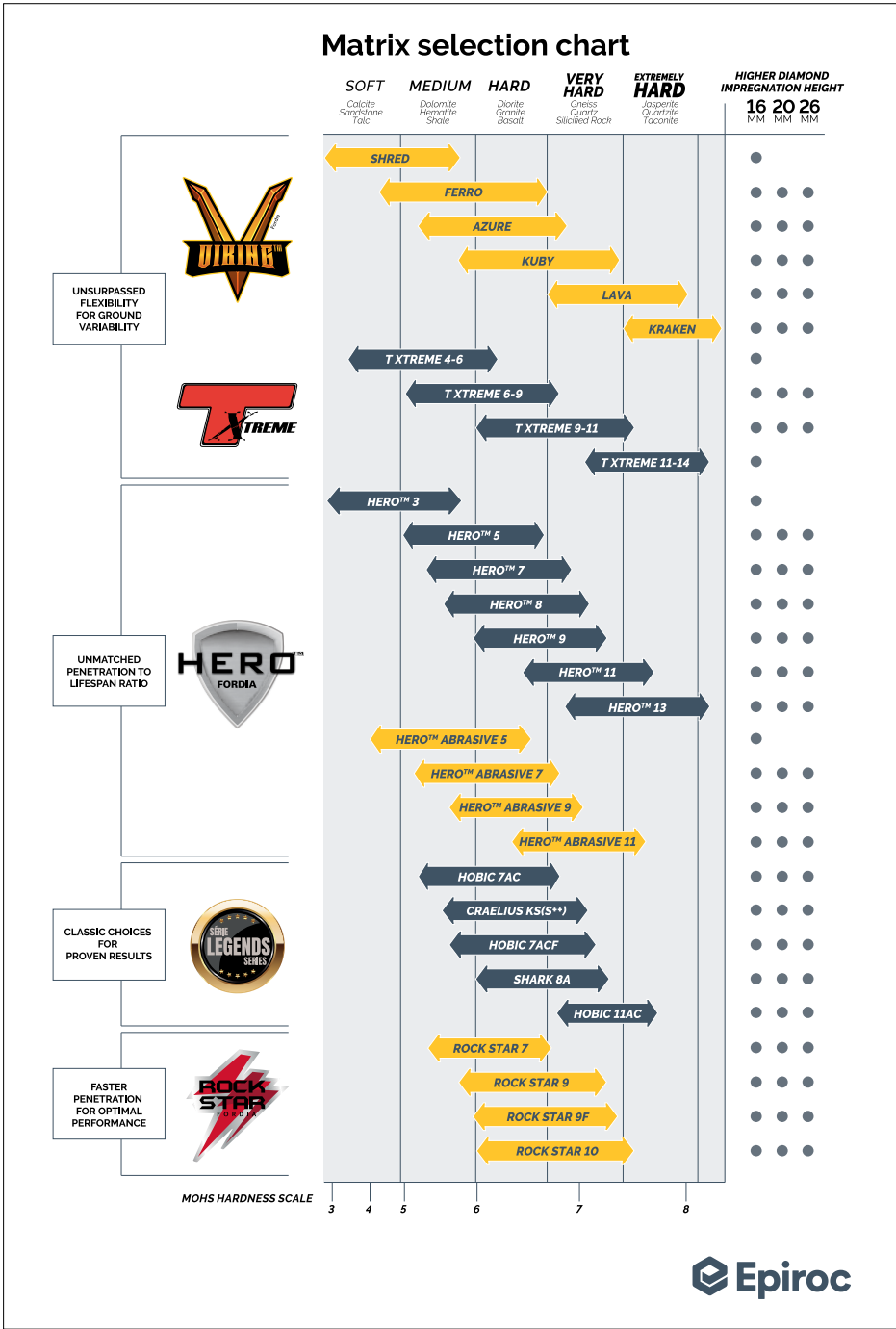
Another option would be to select a drill bit that is suited for a wider range of ground, such as the VIKING™ series. An entire range of ground hardness, from 3-9.5 or more on Mohs scale, can be covered with 6 bits from the VIKING™ series. In this way, you will not have to replace a bit before it wears out or if the ground conditions change.



# Choose the appropriate matrix

According to the results obtained through the scratch test, select the appropriate bit range with Epiroc's Matrix Selection Chart (see next page). You should be able to identify at least one matrix that fits your specific needs.

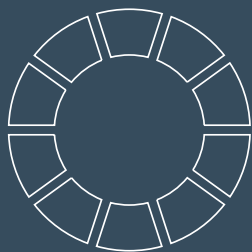
Note that more than one matrix may fit the bit range you are looking for. If the ground is made of a wide range of minerals and several hardness levels have been measured, choose the VIKING™ series. If the ground is relatively homogeneous, you can choose the LEGENDS product line.



# Choose the right waterway configuration

Epiroc offers a wide range of waterway configurations to provide you with the best drilling performance, no matter what type of work needs to be done. All of our configurations are available with different waterway widths and come in most matrix heights.

Make sure to refer to the Fundamental Guide to Core Bit Configurations for more in-depth information and advice.



### Standard

- Provides great fluid circulation from the inside to the outside diameters
- Is available with wider and/or larger waterways



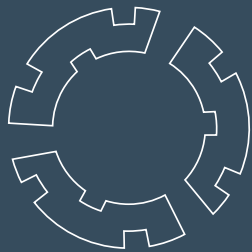
### Pie

- Has pie-shaped openings to ensure greater ejection of rock cuttings that may block waterways
- Is recommended for higher rotation speeds



### Turbo Pie

- Is a freer cutting bit
- Provides the same optimal flushing performance
- In some cases, can reach higher penetration rates when compared with the non-turbo
- Is available with wider and/or larger waterway configurations



### Jet

- Free cutting crown profile designed for 26mm bits with robust geometry
- Excellent choice for competent and non-abrasive rock formations

# Evaluate results and make adjustments

As every type of ground is unique, these rules of thumb may not always be enough to find the perfect bit on your first attempt. Abrasiveness, fractures or competence in rock formations are some other major considerations when it comes to choosing a bit.

Reviewing bit performance is important - it may provide critical information to help you find the right bit and to improve productivity.

If the penetration rate is too slow, using a higher matrix could help solve the problem. For example, let's say you are using a HERO 7 or an AZURE in hard ground and the penetration rate starts to diminish. Your next choice should be a HERO 9 or a KUBY.





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