Intelligent Mining for Quality Control

Importance of using the right gyro survey tools for quality control in Exploration Mining Projects

– Orlando Ramirez, July 2020

Nowadays, when it comes to the exploration of mineral and rock raw materials in the mining industry, the measurement of the trajectory during drilling – both in the exploration phase and in production – is a key factor that those responsible for the geology, drilling, and planning departments must take into account. The main factors that influence the deviation of the well's trajectory are the drilling parameters, that include the geological structure and the drilling method used, in addition to other technological and exclusivity aspects in the mineral area of interest.

The main factors for the well trajectory being off-target are drilling parameters, technological and exclusivity of the mining project.

Many companies and investors fund projects for deposits that initially seem very promising. However, as they advance, the results do not coincide with what was expected. One of the most common causes of this occurrence is due to a simple oversight,

which is the well's trajectory. Likewise, the use of incorrect technologies, combined with the absence of exhaustive quality control of the tools used, can influence the obtaining of unreliable parameters.

On the other hand, the use of standard data synchronization programs often starts from the final data. In comparison, the technology implemented by SPT is based on a calibration control process for each tool, as well as on the measurement check by comparing the In-Run & Out-Run data, which are then automatically evaluated by the SPT software. Stockholm Precision Tools is the only company in this field of exploration drilling, where all of their tools are equipped with this exhaustive quality control process, with a clear view to ensure the client's investment.

When it comes to exploration mining, the main objective for the investors is to obtain the desired results from the mining project, whether the target ore is present at the said location, or not. This would then provide them with the benefits to the capital they have invested for the mining project. Unfortunately, this is not the case. As many times the personnel involved with the project does not take into account the importance of Quality Control from the beginning of the operation. Since the data obtained from the geospatial location and the core retrieved in its exact origin are key to determine the existence or not of the target mineral, on which the economic and environmental impact of the project heavily depends upon.

Advantages of using the right gyro survey tool

Another factor that affects the misuse of a mineralized rock body is the wrong choice of a gyro survey tool, based only on its price. A detailed analysis is needed around the question: What is more expensive: renting a high-precision true-north seeking gyros, such as our GyroMaster ™ and Core Retriever™ (Fig. 1 and 2), or the incorrect evaluation of mineral reserves due to the use of a low cost and unreliable gyro survey tool?

Figure 1. GyroMaster™

Figure 2. Core Retriever™

SPT GyroMaster™: High accuracy True North Seeking Gyro Survey Tool

The gyroscope is determined as an object that is in a rotation, with two fundamental properties*:* gyroscopic inertia or “stiffness in space” and precession, which is the inclination of the axis at right angles to any force that tends to change the plane of rotation. These properties are inherent in all rotating bodies, including Earth.

Gyroscopic inertia and the force of gravity can be used to make the gyroscope function as a directional indicator or compass. If you consider a gyroscope mounted on the Earth’s equator, with its axis of rotation located in the east-west plane, the gyroscope will continue to point in that direction as the Earth rotates from

west to east. Thus, the eastern end will ascend relative to Earth, although it will continue to point in the same direction in space.

This resistance or compensation in force makes an opposing movement around the vertical axis, towards the meridian, so that the axis of the gyroscope always points to the true meridian (or to the true north), which is pointing in a north-south direction.

Due to its operation, based on the rotational force of the Earth and not on magnetism, the GyroMaster™ has multiple applications and its use is increasingly widespread in Geology and major exploration mining projects. These basic concepts can be found on the Internet; however, for the reasons already mentioned, the most important thing is to know how accurate the gyro survey tool is that is being used in a project. (Read more about fundamental principles of gyroscope)

The wrongly called Gyroscope - Reference Gyroscope vs True North Gyroscope

With a quick look at different measuring equipment that uses this technology, it can be seen that there are different classifications: the true north gyroscope (NSG) and the reference gyroscope.

The reference gyroscope lacks an accurate sensor that measures Earth's angular velocity projection, therefore it is unable to find true north, which means it cannot set azimuth. In order to perform its measurement function, it needs to be provided with the starting data. It is not a gyroscope itself, but a reference or indirect

measurement gyroscope (Inclinometer) and, of course, it is not a true gyroscope.

The inclinometer, as its name implies, is a tool that determines the inclination of a well and does not measure direction directly, but rather takes it from an external point and its data depends on the human factor, which causes the accumulation of errors as you go deeper into the well. But the measurement of a tool is not only the inclination, but it is also the direction (azimuth). Since reference gyros lack the technology and sensor necessary to search true north and establish azimuth, they cannot then measure vertical wells. You can find more information about the difference between a reference gyro, true north seeking gyro, and magnetic survey tool.

Reference gyros are unable to measure vertical boreholes/wells

SPT GyroMaster™ is a true north gyro survey tool, that is capable of measuring even at angles of +/- 90º. Its operation and accuracy have been tested in extreme conditions. In wells that are very close to each other or in complex reservoirs where precision is an essential requirement, the GyroMaster™ has been the key to the success of the project.

Risks of using Reference Gyro Survey Tools in Mining Exploration

It has become clear that the use of reference gyro survey tool in extremely important mining projects carries serious risks because their operation depends on the starting data; if it is supplied with

the wrong starting data, the geology department risks ending up falsely believing that they have found a low mineralized. The same is the case with other gyro survey tools that are true north seeking gyros but are not capable of repeating the measurement data during the descent to the well and the subsequent rise, that is why we have classified them as true north gyroscopes, but with low precision.

Initial reference values in reference tools are sometimes obtained using a magnetic compass – increasing the chances of errors

As disastrous for precious metal exploration mining projects is the use of reference gyro survey tools, as is the use of low-precision north finders. Low precision gyros are very similar to the reference survey tools. Many times, they even obtain the initial reference point through a magnetic compass. Furthermore, because their method of operation is a single shot, they do not have the ability to measure continuously, these tools tend to accumulate errors between each measurement interval.

Evaluation of mineral reserves depends on the measurement of the trajectory

Stockholm Precision Tools (SPT) is proud to have specialized, during more than 20 years of constant improvement, in the manufacture of high-precision gyros such as the GyroMaster ™ for the mining sector; the GyroTracer ™, for oil and gas; and, most recently, the Core Retriever ™, capable of simultaneously taking measurements and recovering cores. The precision data of

our tools in inclination is 0.05º, unlike the value offered by other manufacturers whose equipment works with a calibration that allows an error of 0.3º, which results in a constant inaccuracy in the spatial position of the well. If we add the real deviation to this, the magnitude of the error can be 6 to 10 meters, depending on the depth and inclination of the well: the greater the inclination, the greater the projection, and therefore, the Geology department will obtain equivocal data. Regarding the calculation of reserves, having found errors of this kind in multiple projects has been the main driver for writing this extensive article on the importance of Quality Control in the field of exploration drilling.

Tool with an accuracy of 0.3 can be up to 6 – 10 meters off target. Greater the inclination, greater the projection.

Take, for example, a mining body 5 meters wide with a dip of about 45º and a depth of 1000 meters. Using a tool with specifications that contemplate a margin of error of 0.3º in the inclination and several degrees in the azimuth, the possibilities of erroneous calculations on the dimensions of the mining body will be high and, therefore, the probability of not taking advantage of it properly would be devastating.

The following table (Fig. 3) gathers the data and technical specifications of different tools, taken from the websites of their respective manufacturers. Here the error in the final coordinates is evident. Drill trajectory measurement with the use of the GyroMaster ™ true north seeking reduces this error to a

minimum; showing, with real data, that Stockholm Precision Tools is a leader in quality control of trajectory measurement.

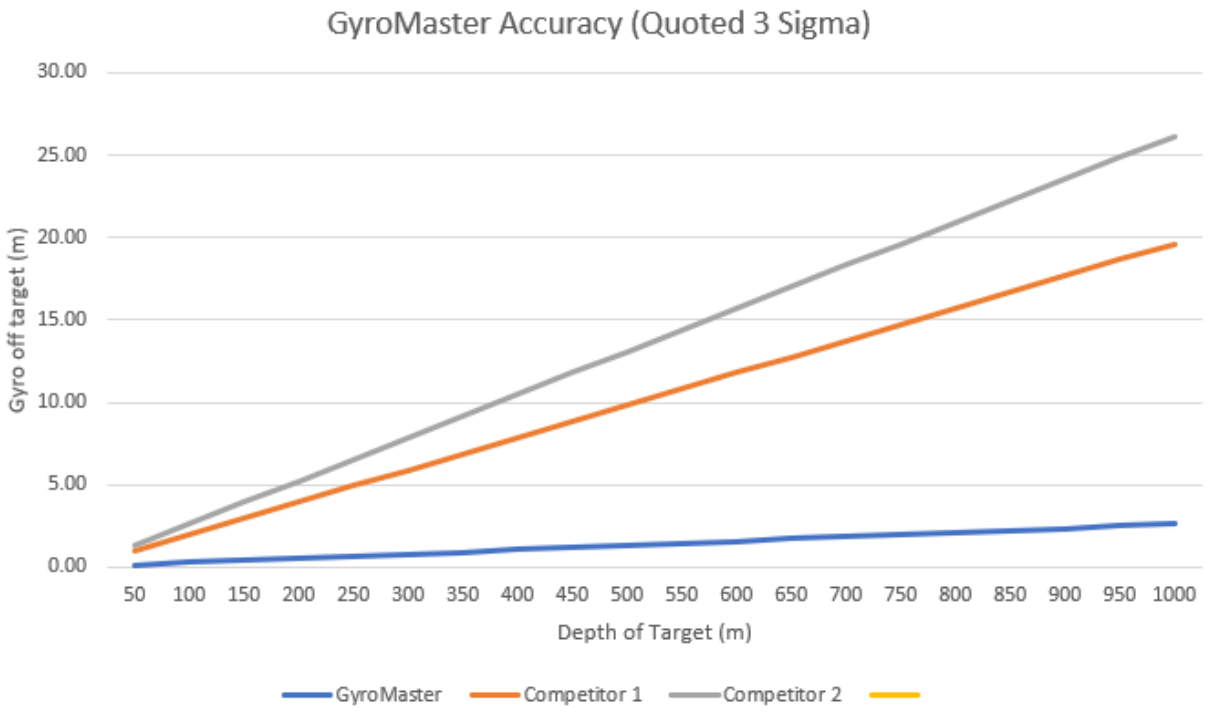

Figure 3. Accuracy of the GyroMaster™, comparing with other tools in the market

Quality Control in Mineral Exploration

In addition to the risks that we have already mentioned in the use of a low-precision north-seeking gyroscope or a reference gyroscope, there is another aggravating factor, and is that those who decide to use these tools in their projects do not have the mechanism and technology to verify that the value of 0.3º of precision in the inclination, that offer the majority of the existing equipment in the current market, coincides with the reality of the measurement; many times it tends to be higher, not to mention the obscure azimuth or direction accuracies stated.

When it comes to quality control, quality assurance in exploration mining projects, Stockholm Precision Tools have implemented a

rigorous model, (see Fig. 4) of controlled checks and audits, making it among the very few companies who have such QA/QC process. This process can be seen in both borehole trajectory measurement and measurement during core recovery in B, N, H, P. Understanding the seriousness of the millions of dollars invested in mining projects and the devastating effect on the environment of errors caused by the lack of information, we are always ensuring the quality control of our tools. Proof of this is also our Gyro RigAligner™, compact and lightweight tool that configures, looks for true north, and aligns the platform in less than 5 minutes. It is also the only 3-axis aligner that works in all directions.

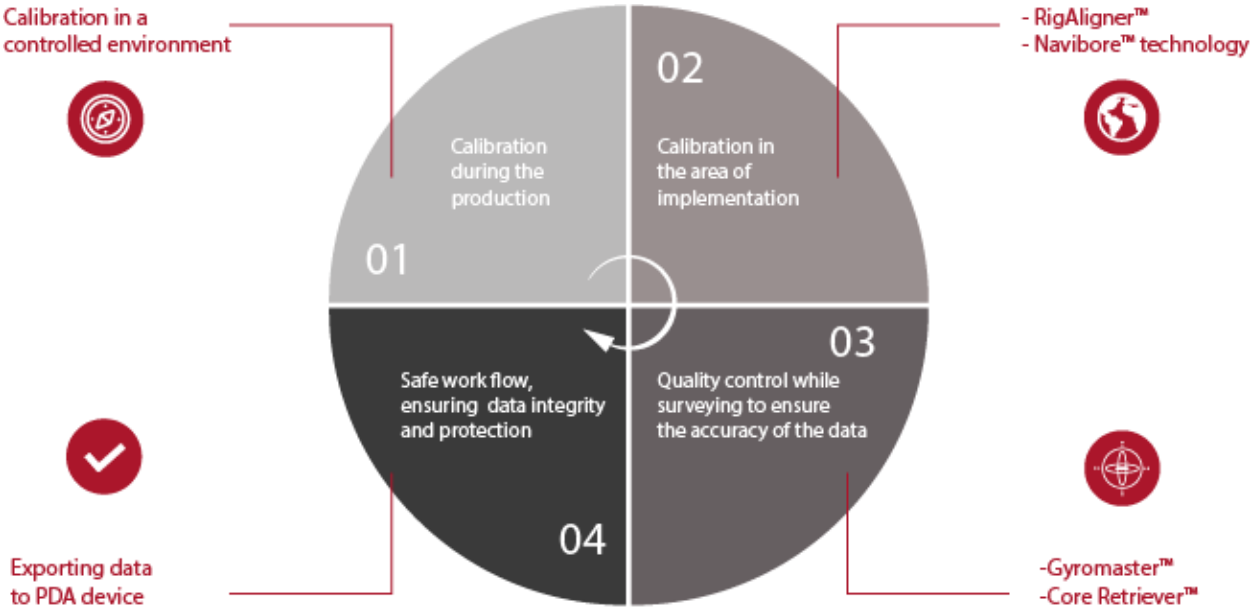

Fig. 4. Quality Control Process implemented by Stockholm Precision Tools (SPT AB)

Ways to Check the Accuracy of a North Seeking Gyro Survey Tool

To check the accuracy of a true north gyroscope or north-seeking gyro, there are several methods; being the most effective the

measurement in a deep well (about 1000 meters approximately) and subsequent comparison between the values of the In-Run & Out-Run, besides, that the initial data is corroborated with the Topography department. Another way to check the precision of a tool is to have a calibration stand, such as the Universal Calibration Stand CF.02 (Fig. 5), designed internally to work with SPT tools.

Fig. 5. SPT Calibration Stand

In other cases, the manufacturer should be required to show the ability to measure vertically -89 degrees, continuously, and to compare that both down and up the value must not exceed 0.15% in the coordinate NS / EO. Let's explain this in more detail: Before selecting the gyroscope to be implemented in a project, In-Run & Out-Run measurements must be made to verify that the azimuth and inclination data are repeated according to the specifications declared by the manufacturer. Both measurements must be evaluated and the data must be the same. It is the best way to

check the quality of the tool, besides that these measurements are made in different inclinations and directions.

Finally, the tool should be tested under harsh environmental conditions. If that opportunity does not exist, it can appeal to use the calibration stand for the Topography department.

The main problem we have detected in our analysis is a lack of a reliable quality control standard for well trajectory measuring technologies globally and that the client is often guided by published specifications, by the ease of use or by other factors unrelated to the precision of the tool. Consequently, this can lead to erroneous decision making, financial losses for investors, and environmental damage that could be catastrophic.