Automated Coal Seam Identification Improves Drilling and Blasting Programs

BY STEFANO PRAMANO AND ALYSSA WEDLER

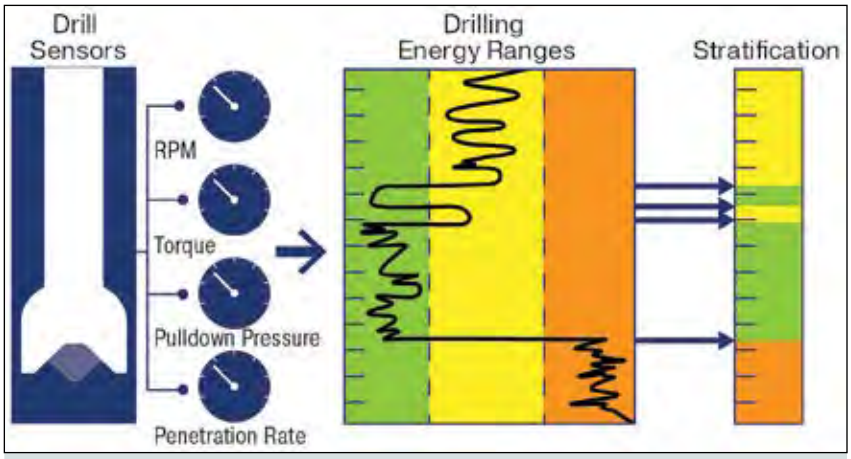

Figure 1—The stratification module uses drill sensors to determine energy ranges and correlated hardness of material in a drill hole to refine drilling and blasting practices.

Identifying coal seams at open-pit mines can be challenging due to several variables, including seam thickness and incline, quality, properties of the strata that blankets the seams, and more. Many mine sites leverage gamma-ray logging technology to characterize the material properties in a drill hole. This wireline logging technology involves lowering a device into a drill hole and measuring the gamma radiation at various depths, thereby helping to determine the material lithologies within each hole. But gamma ray logging is a manual, pain-staking process, and often requires time-intensive analysis before the drill-and-blast crew can receive their targeted drill patterns.

Two coal mines, one in Indonesia and in Australia, recently replaced their manual gamma logging processes with Modular Mining's ProVision Stratification module. This is part of the ProVision high-precision Machine Guidance system for drills, which improves the productivity of blasthole drill rigs by providing continuous, high-precision guidance to drill operators in real time. As a result, the mine in Indonesia eliminated more than 33% of the time spent on its total drill-charge-blast sequence, as well as the need to rent a gamma logging device. The mine in Australia increased its dig rate by more than 11% over a six-month period after switching to the ProVision stratification module, enabling them to move an additional 1.7 million tons of coal during that period.

Challenges With Gamma Ray Logging

While gamma radiation is commonly used for detecting coal seams, it is not without limitations. Gamma ray logging records the natural gamma radiation from material adjacent to a drill hole. Since coal is typically less radioactive than other material (especially shale), miners are often able to leverage gamma ray logging to distinguish coal seams by comparing the radiation results from varying depths within a drill hole. But some coal-bearing regions, where limestone or sandstone is also present, will likely require additional methods to accurately identify coal seams, due to the similarly low radioactivity of these materials. Likewise, gamma ray logging requires a significant amount of time for manual analysis and handoff from the engineering department to the drill-and-blast crew. And if a site has a limited number of gamma logging tools, the process is further slowed because each tool can only analyze the gamma radiation from one hole at a time.

High-precision Machine Guidance and Drill Hole Stratification

The ProVision Machine Guidance system provides open pit mines with high-precision positional accuracy up to one centimeter. This precise guidance helps increase total tons moved and improves material movement accuracy, while decreasing costs associated with working outside of the mine plan. The ProVision system for drills provides continuous onboard drill-hole position navigation, depth, and angle to dramatically improve blasthole drill-rig efficiency, utilization, and compliance with the blast plan. Additionally, the high-precision GNSS navigation continuously guides operators through poor visibility and while working at night, further improving drill utilization and hole accuracy.

The ProVision system's optional Drill Hole Stratification module collects real-time data about drilling factors like RPM, torque, air pressure, and amperage required to drill through material, then uses this data to compile an energy profile for each drill hole. The energy profile correlates to rock hardness to automatically delineate the material strata in each hole. This information allows mine sites to attain maximum material output by refining drill patterns for each bench based on the results of the previous bench's drill holes and geological patterns. In addition, the improved explosives management, safety factors, fragmentation, and overall pit design that the module helps provide can play a major role in maximizing a mining organization's productivity.

Improved Efficiency in Indonesia

An Indonesia coal mine improved drill-blast sequence efficiency by more than 33%. To remain competitive in a tight market, a mine in Indonesia streamlined its mining sequence with through-seam blasting (TSB). Since TSB typically requires a miner to drill to a fixed depth in level benches across the pit, accurately identifying the coal seams' location, depth, thickness, and other parameters is vital for optimal blasting.

Prior to Modular Mining's involvement, the mine relied on manual gamma logging to identify the coal seams, but since they had only one gamma logging tool, were limited to executing only one through-seam blast location each day. Additionally, gamma logging delayed the blasting process for 24 hours as a result of manual data capture and analysis required to identify the coal seam. Consequently, the mine's drill-charge-blast sequence required a minimum of three full days to complete; the mine recognized that by speeding up this process they could significantly increase their productivity potential.

Since the mine already utilized the ProVision system for drills, Modular Mining's Performance Assurance (PA) team, which visits customers on regularly scheduled intervals to help maximize the value being delivered by their Modular Mining technologies, discussed the advantages of also leveraging the drill hole stratification module. Beyond its ability to improve blasting and fragmentation results, the stratification module has the potential to improve a mine's ability to accurately identify and locate coal seams faster than a gamma logging process typically can. Since coal is soft and relatively easy to dig through, its energy profile varies dramatically from the harder material surrounding it. (See Figure 2)

After deploying the stratification module to the site's 10 drill rigs, the PA team leveraged the collected data to develop an automated report that identifies the mine's coal seams and communicates estimated explosive requirements, for all drilled holes, to the blasting crew immediately.

The stratification module enabled the drill-and-blast team to increase their TSB capacity 10-fold, from only one location daily through the gamma logging process, to up to ten locations simultaneously with the stratification module (one from each drill rig). Additionally, the ProVision system helped the mine increase their drilling productivity by eliminating the 24-hour wait period for manual data collection and analysis. Now, they can identify coal seams and prepare the required explosives immediately after drilling.

Since the new automated report sends explosive requirement estimations to the blaster crew immediately, the mine was also able to eliminate the manual calculation and handover process from engineers in the office to the blast operations team in the field. All data now transmits instantly and automatically.

Prior to Modular Mining's involvement, the mine's complete drill-charge-blast sequence took at least three days to complete; by leveraging the ProVision system and thus eliminating the need for manual logging and processing, the mine now requires less than two days to complete the same sequence.

Dig Rates Improve in Australia

An Australian coal mine improved dig rates by more than 11% using the stratification module and Measure

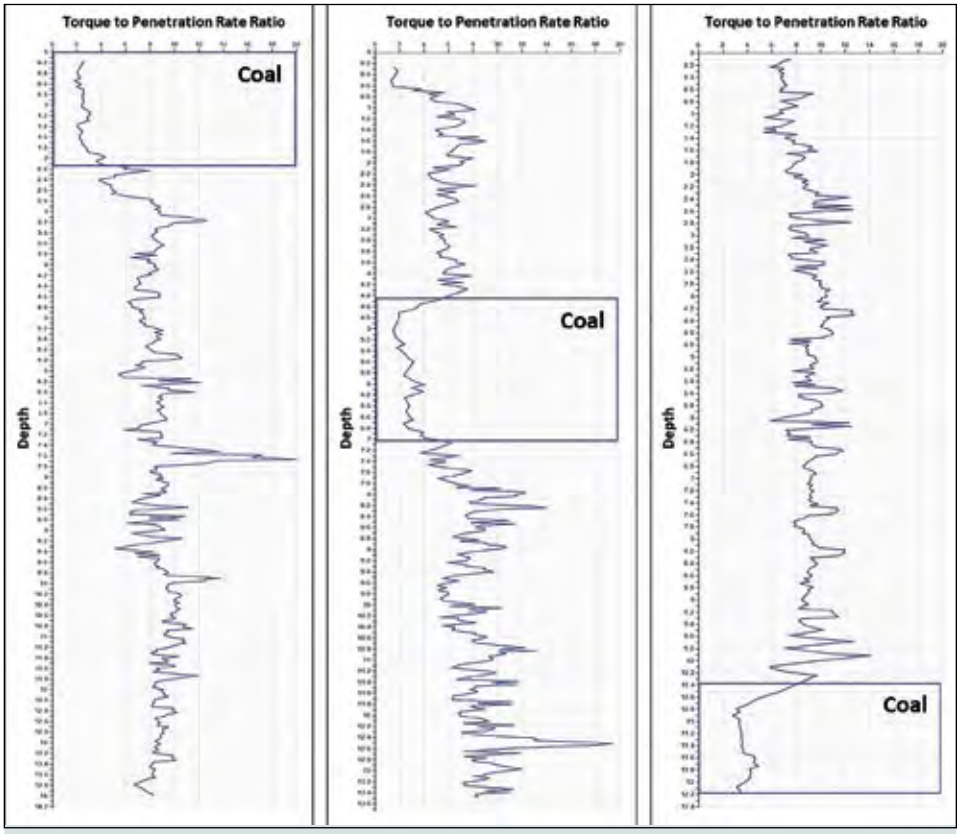

Figure 2—Example report is generated from the drill data collected by the stratification module. Energy profiles that show lower torque-to-penetration-rate ratios indicate softer material, helping to identify the precise location of the mine's coal seams.

While Drilling (MWD) data. The strategy for a large mining conglomerate included the company-wide increase of coal production by 3 million metric tons (mt) this year through improved coal recovery. The company saw accurately mapped stratification as a means to improve their blasting quality and resulting shovel-loading efficiency across their sites. While one of these sites originally leveraged gamma ray logging to identify their coal seams, they called on Modular Mining to instead integrate the stratification module into their existing ProVision system for drills. After a six-month trial period, the mine was confident in the stratification module's ability to accurately map the coal seams at their operation, and fully replaced the manual process with the stratification module.

Switching from manual gamma logging to the ProVision system's stratification module also enabled the customer to leverage MWD data in their site processes. MWD data facilitates accurate mapping of geological models and can be used in real time to provide the drill-and-blast team with more accurate information. This improves the fragmentation of the site's overburden and reduces coal dilution.

While MWD alone is often insufficient for identifying coal seams, due to drilling parameter measurement limitations of rotary drill rigs, MWD in combination with a rock-recognition system like the ProVision system's stratification module can consistently detect a coal seam without relying on geophysical data like gamma radiation. Additionally, integrating MWD and stratification provides a greater margin for error than gamma ray logging, while overcoming the low specificity and high variability sometimes experienced from existing MWD methods that do not also consider stratification.

Implementing the stratification module enabled the mine to:

- Improve blasting costs, efficiency, and safety by characterizing the strata of overburden; and
- Reduce the potential for low wall failure by identifying weak bands.

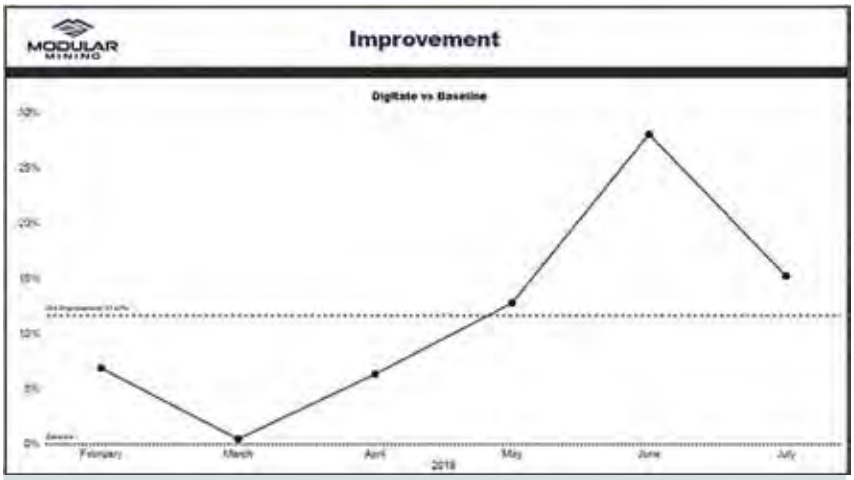

Figure 3—Leveraging MWD with the ProVision stratification module enabled the mine to improve their dig rate by 11.6%.

The improvement in blasting effectiveness can especially be seen in the mine's shovel efficiency when loading the blasted material. In addition to the improvements above, Modular Mining's analysis of the dig rates across the site also shows an increase of 11.6% over the six-month period by implementing MWD and the ProVision stratification module. (See Figure 3)

Overall, replacing their gamma ray logging process with the stratification module and MWD enabled the mine to move an additional 1.7 million mt of coal over the six-month period, bringing it closer to hitting its corporate goal.

These success stories demonstrate what can be achieved by replacing manual, time-intensive gamma ray logging techniques with automated blasthole stratification capabilities.

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Benefits of Stratification

Optimized Fragmentation

Stratification can improve blast-loading design, blasting performance and dig-ability, all of which impact successful fragmentation. The ProVision system leverages data from geological patterns to send up-to-date blast patterns to equipment operators automatically.

Improved Coal Control

By significantly improving material fragmentation and accurately identifying coal seams, stratification can also reduce coal loss or dilution.

Improved Safety

Since stratification can improve blasting performance and blast-loading design, it can significantly reduce the amount of fly rock produced by explosives. Additionally, improved explosives management helps to reduce misfires and hole failures, and the ProVision system's high-precision navigation provides accurate collar location, which ensures better compliance to plan while significantly reducing rework and field surveying.

Improved Final Pit Shape

Stratification can also reduce blasting back-break by allowing for more precise charge placement. This helps to ensure the accuracy, stability and integrity of pit walls. Knowing the various material compositions (derived from the energy and hardness levels) also allows for more control around geotechnical structures and helps preserve the pit floor grade.