



Challenging the low-grade narrative

The mining sector should stop striving for lab-based precision and focus on making staged orebody knowledge improvements with these technologies, Dan Gleeson hears

Current industry perception is that declining feed grades are an unavoidable consequence of ore deposit geology and mass mining technologies for increasingly mature mining operations, or the “new generation” of low-grade operations. While true at the front “digging” end of mining operations, the old adage of “grade is king” is resurfacing, according to Jon Rutter, Business Development Manager for Mining and Mineral Processing at **Thermo Fisher Scientific**. This is where applying the lever of bulk ore sorting (BOS) can impact the economics of an operation.

Rutter explains: “The grade in the ground may be lower, but the opportunity exists to significantly enhance the delivered grade to the already installed (or planned) capacity of the recovery plant by exploiting the retained

heterogeneity.”

An industry focus on throughput as the main driver of revenue has led to a bulk average mentality with respect to in-situ cut-off grades. In many cases, average grades used to define bench- or stope-scale processing destination decisions such as mill, dump leach, waste, etc include significant sub-volumes of material outside cut-off specifications, Rutter says. An averaging approach ignores potentially exploitable grade heterogeneity below the scale of the minimum mining unit even though significant localised grade heterogeneity is a dominant characteristic of many base and other metal deposits and ore types.

“My experience in deploying BOS solutions in mining operations has demonstrated that adequate heterogeneity

The CB Omni Agile Online Elemental Cross-Belt Analyzer uniformly and precisely measures a wide range of industrially relevant elements, for entire raw material process streams, according to Thermo Fisher Scientific

is retained in most orebody systems despite the mixing and ‘smoothing’ effect of the blast, load, haul and crush interface,” he told **IM**.

Many detractors of BOS will claim that adequate heterogeneity does not exist in bulk mining deposits, but Rutter’s experience has so far shown that to not be the case.

“The ultimate test is presented in many porphyry copper processing plants,” he explains. “Despite being a generally disseminated ‘bulk-style’ mineralisation, mined in 15-m benches, several hundred thousand tonne blasts, 80-100 t shovel buckets, 300 t trucks, 2,000-8,000t/h crushers, blended and crushed to circa 100 microns in 160,000 t/d milling and flotation plants, a significant heterogeneity signature is still present in the online sampling analysers!”

A key focus question for BOS is ‘what’ are you trying to achieve and ‘where/how’ do you wish to operate?

The focus word is in the title: bulk.

“We do not need assay lab precision,” Rutter says. “We need to ‘measure’ (or more

accurately ‘sense’) the metal content of the pod of material adequately enough to be ‘right’ far more often than we are wrong. The measure of ‘rightness’ needs to incorporate the error bar of the entire system. This can include precision of the sensor, integration time required (commonly linked to precision), the metals (or non-metals) being targeted and the method or location of deployment.”

This commonly distils down to what the planned ore loss and dilution in the BOS system is, with the decision (accept or reject) being above or below a threshold – commonly being either grade or a geometallurgical attribute.

“What is not well discussed or recognised in the industry is that these factors are not ‘fixed;” Rutter says. “They are customisable and can be modified to an operation’s needs.”

They are similar to “modifying factors” in the mine planning and scheduling sequence, whereby mine planning selects a SMU (smallest mining unit) with a chosen ore loss and dilution suitable to the mineralisation style and scale of mining.

In BOS you can select a SDU (Sensor Diversion Unit), which could allow the same 15,000 t dig block selected as the SMU to have smaller SDUs dependant upon the heterogeneity and the sensors themselves. These modifying factors can include:

- Sensor type:
 - o Elemental – Prompt Gamma Neutron Activation Analysis (PGNAA), X-ray Fluorescence (XRF), Laser Induced Breakdown Spectroscopy (LIBS), etc;
 - o Mineralogical – hyperspectral imaging (HSI), magnetic resonance (MR);
- Requirement for surface, partial or fully-penetrative measurements;
- Base metal mines (Cu, Ni, Pb, Zn, etc) versus bulk commodities (cement, phosphate, manganese, iron ore, etc);
- Precious metals (eg: arsenic);
- Precision required (eg: 0.1% Cu +/- 0.01%);

- Integration time (eg: 15 seconds, 30 seconds, 1 minute, 5 minutes, etc); and
- Belt loading and capacity (metres/second and tonnes/metre)

“The net result is a variety of SDUs are possible depending on the chosen matrix of deployments selected above,” Rutter says.

He also outlined some of the key challenges for determining the best solution for a BOS opportunity, saying it needs to account for:

- Downtime on a conveyor for installation;
- Additional downtime or loss of production for any required “online” calibration;
- Active diversion/intervention versus online process control solutions;
- Reject stream diversion capability or capital expenditure requirement;
- Reject stream haulage/removal cost and/or capital expenditure;
- Possible reject stream destination (eg waste dump or ROM leach); and
- Value proposition driven by increased grade, enhanced throughput capability and/or ability of processing facility to react to grade or information supplied.

This is where Thermo Fisher Scientific believes it has a differentiated offering for the mining sector; an offering developed with these “modifying factors” front of mind that has complementary solutions for bulk material on belts and in plant slurries.

The Thermo Scientific™ CB Omni™ Agile Online Elemental Cross-Belt Analyzer is designed for high throughput, bulk ore applications where decisions are made at variable scales of measurements from as low as tens of tonnes at a time.

The company provides the option of using either neutron sources – up to 78 ug of Californium 252 or an electronic neutron generator – and is combined with an option of 1 to 4 high volume NaI detectors, it says. The net effect is, the company says, a much higher saturation of neutrons to measure

and quantify the desired elements at very low grades with greater precision.

“Because calibration is largely completed before shipment, on-belt deployment is typically limited to brief static checks and optional dynamic calibrations using known standards spanning the elemental ranges of the mine’s own ore (no belt cuts needed), avoiding lengthy online campaigns and minimising downtime,” the company says.

The CB Omni allows short integration times – effectively pods of ore on the conveyor or sensor diversion units (SDUs) – and high analytical precision across a wide elemental range, including the light elements that cannot be measured by XRF, Thermo Fisher claims.

Rutter added: “Because the CB Omni is capable of measuring a wider array of metals and lighter elements, a back calculation of mineralogy or gangue can be completed to enable ‘value add decisions’ according to metallurgical attributes. Elements such as Cu, Fe, S, Si, Al, Mg, Ca, K, Na, Mn (plus more) can be measured accurately to allow for discrimination for ore destinations such as a leach pad or a sulphide mill.”

The Thermo Scientific GS Omni slurry PGNAA analyser extends the same philosophy into the processing plant. Using a labyrinth flow cell and multiplexed sample handling, GS Omni (Gamma Slurry) measures multiple slurry streams in real time, capturing both major metals and key gangue or deleterious light elements that drive recovery and reagent consumption.

“Together, CB Omni Agile on the conveyor and GS Omni in the plant provide a consistent sensing backbone from pit to product,” Rutter explains. “They allow miners to apply bulk ore sorting and downstream process control using continuous, representative PGNAA data rather than sparse sampling alone – and to adjust the ‘modifying factors’ of BOS (SDU size, cut-off thresholds, diversion logic) as ore types, market conditions and operating strategies evolve.”