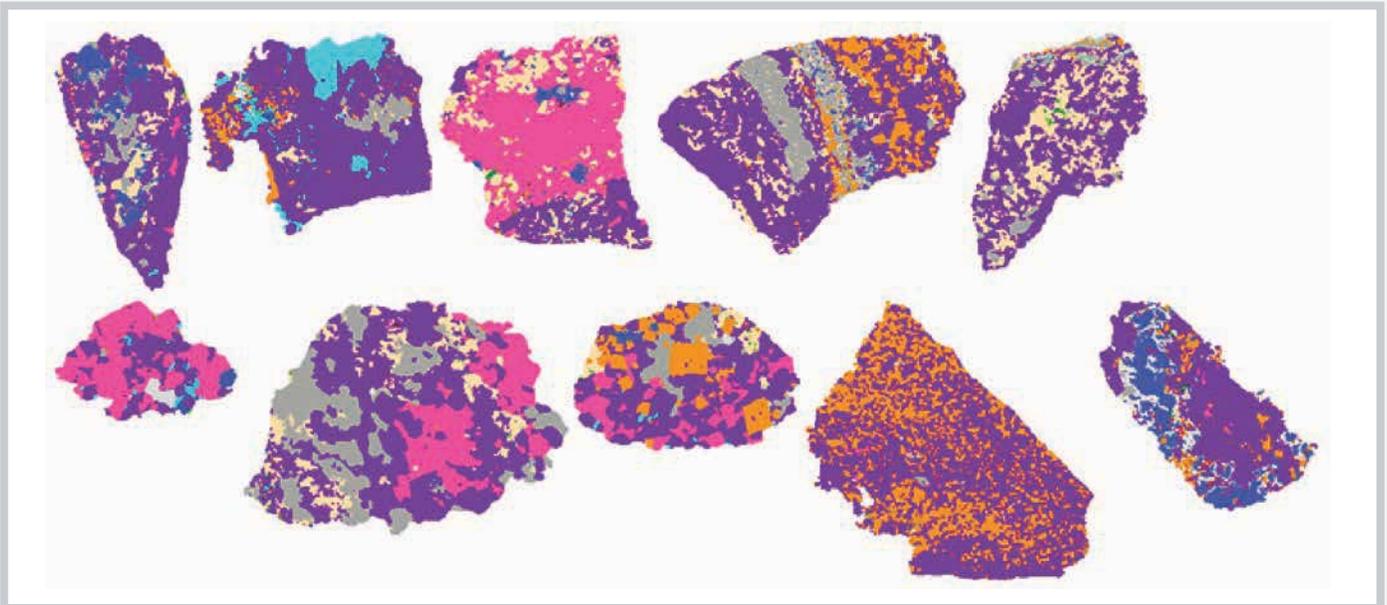


Maximizing Concentrator Economic Performance

SUCCESS IN A COMPETITIVE MINING ENVIRONMENT REQUIRES MAXIMIZING THE OPERATIONAL EFFICIENCY OF ALL ASSETS.



A zinc ore showing QEMSCAN images of sphalerite (purple) associated with galena (blue), pyrrhotite (pink), pyrite (orange), quartz (grey), carbonates (dark blue), orthoclase (cream).

Glencore Zinc asset managers are currently working with XPS to benchmark operational results for individual Zn concentrators, an initiative that will guide mining and processing decisions and capital investment.

Metals within ores can distribute themselves over a broad array of minerals even within a single deposit, and it is not uncommon to find that one or more such minerals represent a fraction of the metals content that cannot be economically exploited. This gives rise to the concept of “recovery entitlement”, or the fraction of the head assay of a pay metal that occurs as recoverable minerals. This number is important to know, since the anticipated cash flow from a mass of ore and the metallurgical upside potential of the associated processing operation is no better than that which is dictated by the recovery entitlement. The entitlement calculation impacts mining cut-off grades, production planning and asset valuation.

The benchmarking exercise currently underway with XPS and Glencore Zinc involves fourteen separate operational assets spread across five continents, representing a truly global initiative that is being applied to a broad spectrum of zinc deposit types and sizes. A rigorous

process of feed sampling and validation has been initiated which involves definition of short to medium term feed grade variability (from historical operating data) and collection of five random feed samples which are then individually validated as being “representative” feed ($\pm 2\sigma$ for all pay elements). It also involves the creation of a composite to represent the concentrator operation.

Feed composites are analyzed to determine the recovery entitlement of zinc, lead, copper (if appropriate), and precious metals (usually Ag, Au). XPS provides high-precision assessment of metals deportment and entitlement using advanced process mineralogical methodologies (QEMSCAN modal mineralogy, EPMA microanalysis of mineral species, LA-ICPMS laser ablation for trace analysis of solid solution). Comparison of metals entitlement versus actual operational results yields an indication of the success of the operation, and on a general level the magnitude of potential for improvement.

The benchmarking exercise beyond the Phase 1 comparative feed survey is preparatory for a deeper level of Phase 2 performance assessment based upon plant sampling. In a plant sampling exercise, XPS uses the

same mineralogical tools for analysis but includes size by size performance data and liberation data, in conjunction with performance data for individual minerals and metallurgical assay balancing across key nodes in the separation process. The data from the Phase 2 study defines not only the snapshot of performance during the time of sample collection but also the relationships between parameters of economic importance such as mineral liberation-based limits of grade versus recovery.

The detailed Phase 2 survey allows the assessment of opportunities for improvement, especially on an economic level. The net revenue is clearly improved by reaching toward the limits of entitlement, but revenue is also affected by smelter/upgrading terms, concentrate grade, transport costs, presence of penalty elements, and partitioning of precious metals into the various concentrates. The best operating point for the plant from an economic standpoint may vary according to changes in the market environment, including the relative values of the pay metals in a multi-element asset. Glencore Zinc will combine the technical results of the Phase 2 survey with proprietary economic modelling to set metallurgical targets which will dynamically maximize economic results. In addition, Phase 2 will potentially identify new technical

opportunities that can either be explored in the plant, or tested in a laboratory setting as a Phase 3 optimization program.

It is recognized during this benchmarking initiative that ores are rarely homogenous. Nonetheless, variability is frequently measurable and mappable, allowing “geometallurgical units” to be defined within orebodies. It is not uncommon in general mining practice for orebodies to be defined in such a manner, for example as “sulphide zones” versus “oxide zones”. The better an ore body can be defined by geometallurgy, the more useful production models become. Thus the benchmarking exercise also anticipates Phase 4, which is the geometallurgical characterization of future ores from Glencore Zinc assets.

The collaborative effort between XPS and Glencore Zinc illustrates the power of process mineralogy and geometallurgy for benchmarking and optimizing metallurgical operations. Mineralogically based process models allow objective assessment of asset performance, as well as yielding proactive tools for maximization of asset revenues and identification of process opportunities, allowing the most efficient realization of economic potential.

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ASSET PERFORMANCE MONITORING

Process Controls

MOST OF US ARE WELL AWARE OF OUR ‘CHECK ENGINE’ STATUS LIGHT IN OUR VEHICLES.

This is a constant monitoring device to alert us of failure/malfunction within our engine or the emission related systems. It helps to prevent expensive engine damage and provides key diagnostic information in where a sensor, valve etc. malfunction has occurred.

Asset and performance monitoring monitoring is crucial if we are going to fully realize the optimum returns from the large investments which are made in mining and mineral processing plants and operations. At the instrument level, this is far more possible now than it was three decades ago.

XPS Process Control has used the AMIRA P893 Concentrator Benchmarking Study to drive instrumentation and automation reviews using predictive maintenance and fault detection tools. The control system vendors

(like ABB and Emerson for example) also offer **diagnostic** tools within the control system to do key monitoring and diagnostics continuously.

XPS Process Control has experience with asset monitoring and can perform a review of your plant or process. It starts with a Process Control questionnaire and includes a site visit and final report complete with recommendations. Recently, we have reviewed the mill controls at Chelopech and Antamina. Contact Phil Thwaites or processcontrol@xps.ca for further information on how to review your Mill’s controls and benefit from improved asset monitoring and improved process control. We take it for granted in our private and company vehicles – as it helps us to keep our own vehicles running and safe!

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