Wednesday 25 November
Session one: Mining & Minerals

KEYNOTE: The Hidden Cost of Poor Sampling: Quantifying Financial Losses in Grade Control Practice

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Grade control decisions directly determine whether material is processed as ore or discarded as waste, making sampling quality a critical economic factor in mining operations. Inadequate sampling practices can lead to systematic errors in grade estimation, resulting in ore loss, dilution, incorrect mine planning and significant financial losses. This study evaluates the economic consequences of manual and inappropriate sampling practices in grade control and their impact on reconciliation results. The methodology combines a reconciliation framework with a sampling validation program. A reconciliation matrix was used to analyse discrepancies along the mining value chain, from long-term resource models to short-term planning, mining operation and plant production. In parallel, grade control sampling procedures were investigated by comparing traditional blast-hole drilling combined with manual sampling with reverse circulation (RC) drilling equipped with an automatic sampling system. The comparison was validated through twin-hole drilling campaigns and the analysis of manual samples, automated samples, and total recovered material. The results show that manual sampling and low-recovery drilling methods introduce significant biases and imprecision in grade estimation. In the case study, the traditional drilling system produced systematic grade overestimation due to incomplete material recovery and particle size segregation, while manual sampling generated additional errors related to increment delimitation, extraction and weighting. The results demonstrate that inappropriate sampling practices can lead to substantial financial losses, often exceeding the cost of implementing reliable sampling systems. Improving sampling precision and accuracy is therefore essential to reduce economic risk and ensure reliable grade control decisions.

Split Ratio Dependence of Variance Suppression in Rotary Versus Riffle Sample Splitting

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Accurate particulate analysis in industries such as mining, agriculture and pharmaceuticals depends critically on representative sample division. While rotary splitters are widely recognized for their practical efficiency, their systematic sampling mechanism is theoretically incompatible with the randomness required for calibrating Gy's Fundamental Sampling Error (FSE) formula in heterogeneity studies. This paper experimentally investigates whether a rotary splitter suppresses compositional variance compared to a conventional riffle splitter when operated at different split ratios. Using a crushed basalt lot seeded with four tracer additives of varying densities (rock chips, steel balls, lead balls, tungsten carbide chips), the performance of a Rocklabs Boyd Elite Rotary Sample Divider was evaluated at split ratios from 5% to 25% and benchmarked against both a vibratory feeder (worst-case heterogeneity) and a 20-vane riffle splitter. Results demonstrate that the rotary splitter significantly suppresses variance at higher split ratios (≥15%), reducing particle count variability by 40–50% compared to the riffle splitter. At the lowest setting (5%), the rotary splitter performs worse. This variance suppression is attributed to the larger extracted sample mass and the high number of incremental cuts (~246 vs. 20), which more effectively average out local segregation. The study concludes that while rotary splitting is unsuitable for FSE calibration due to its non-random mechanism, it is a superior tool for routine sample preparation where compositional representativeness is the primary goal, provided it is operated at an appropriate split ratio (15–20%).

Sampling Difficulty Index

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It's been a long journey since Professor Pierre Gy started developing the Theory of Sampling (TOS) in the 1950's. Since then, TOS has been deeply discussed, and it's been continuously in development by recognized specialists all around the world.

One of these developments refers to the Sampling Difficulty Index defined by Dominique Francois-Bongarcon as the relationship between grade of the element studied and the modelled relative sampling variance, provided a plausible model that has been calibrated for the liberation factor. This Index intents to help optimize everything sampling to cater to the worst conditions that will be met, thus complementing the knowledge acquired while performing a Heterogeneity study of a geological deposit (expressed in an optimized sampling protocol) with a new proxy of information indicating the level of difficulty when performing sampling over a range of sampling/geological conditions from a low grade/disseminated ore, or high grade/nuggety ore, for instance. This is particularly important for gold mineralization as they invariably present a non-obvious relationship between grade and free gold liberation size, so that the worst combination for sampling between the grade and the corresponding liberation size (understanding liberation size as the size where the contributors of variability have been liberated) can only be predicted through a specific analysis using the Difficulty Index.

In summary, the Difficulty Index tells us what grade offers the worst sampling challenge. In gold, for example, it will indicate if the presence of coarse gold should worry us or not, to prevent us from naively thinking coarse gold = problem… It will have an impact on the prep protocols and field sampling procedures that we will decide to use.

Session two: Open

Mind the Gap: Annex G - Balancing Sampling Intent with Practical Operational Constraints

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Sampling correctness is a critical prerequisite for the sampling and inspection industry. It can be defined as the condition in which a sample is demonstrably representative, unbiased, and of sufficient precision to support valid decision-making with known and acceptable uncertainty.

International ISO standards articulate this objective through principles of representativeness, bias control, and validity of results. However, a persistent gap exists between ISO standards, standard operating procedures and grassroots sampling practice. This gap is amplified by linguistic ambiguity, particularly in multilingual environments where English is not the primary language.

ISO standards are intentionally outcome-based and non-prescriptive, relying on professional judgement to translate abstract principles into field execution. SOPs attempt to convert principles into Instruction. However, they frequently depend on terms such as representative, random, sufficient, where practicable, and as appropriate. These expressions are conceptually dense and vulnerable to misinterpretation. In non-native contexts, they may lack direct equivalents or maybe interpreted colloquially rather than scientifically. As a result, procedures may be followed in form that may diverging or undermine sampling correctness without overt non-compliance or malice.

Operationally, such ambiguity can create conflict with real-world constraints. Common deviations include skipping or simplifying a procedure, informal equipment substitution, reinterpretation based on personal experience, incomplete chain-of-custody practices, and unreported departures from sampling plans. These behaviours are typically adaptive responses to external pressures such as weather, access limitations, safety, stakeholder demands, tight schedule, and even overconfidence from prior experience.

While such adaptations enable efficiency, they can introduce systematic error, bias, or loss of representativeness—effects often invisible downstream.

Alignment of ISO Standards and internal SOPs devolve when human practice fills gaps pragmatically. Compliance may be demonstrable and analytical performance robust, yet the sample itself may be compromised. Addressing this requires clearer SOP language, recognition of human judgement, and alignment between standards, procedures, and real-world conditions.

The Integrated Reference Core Shed: Infrastructure as an Enabler of Sampling Quality Management

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1Independant Consultant

Recent literature has identified sources of bias in the sample-to-data chain that classical Theory of Sampling did not fully address: over-emphasis on downstream data processing, false confidence in written protocols without inspection of implementation, and siloed management across sample collection, preparation and analysis (Domínguez, 2021). The response has been articulated mainly in management terms — Quality Management as proactive practice. This paper proposes a complementary and equally necessary response, articulated in infrastructural terms: the Integrated Reference Core Shed as a physical architecture that enables Quality Management by design.

The reference core shed is not a real installation, but a synthesis of design principles derived from industrial-scale experience in copper operations. Its defining features are: (i) a unified sample value chain from receipt to definitive storage, treated as a single system rather than a collection of processes; (ii) sequential unitary processes in linear flow with no backward crossing, eliminating cross-contamination and lost traceability; (iii) standardised sample support at fixed intervals, homogenising the comparison unit across drill holes; (iv) rack/position-level physical traceability integrated into the operational system, not layered onto it; (v) dedicated sub-zones physically isolated by function; (vi) capacity dimensioning at operational peak with explicit contingency factor, so protocols remain executable under real load.

The paradox is that the reference model draws less from mining core sheds and more from mature traceability industries — supermarkets, postal networks, 3PL logistics — where value chain integration and end-to-end traceability are operational default, not aspirational goal.

The next frontier of TOS is not mathematical. It is architectural. Infrastructure and Quality Management are complementary, not substitutes, and both must advance for representativeness to hold in production.

Representative Sampling in Mineral Processing: TOS Compliance in a Consolidating Global Supply Market

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1CONSEP

In mineral processing, profitability and sustainability depend on accurate knowledge of the properties of every material stream—whether feed, product, or tailings. Understanding the chemical, mineralogical, and physical characteristics across all stages of beneficiation is essential to optimise efficiency, reduce environmental impact, control costs, and maximise value. Sampling delivers this knowledge, enabling metallurgists, engineers, and managers to make informed, data-driven decisions.

The supply market for sampling technology has changed significantly. What was previously a fractured market has become increasingly consolidated. Through acquisition, Consep has brought together the sampling experience, product ranges, and installation histories of Consep, Heath & Sherwood, Quality Handling Systems, and Harrison Cooper, creating a broader technical base from which TOS-compliant solutions can be designed, supplied, and supported.

This paper examines the role of sampling systems designed in strict compliance with the Theory of Sampling (TOS) in generating reliable data for operational decision-making, and considers the implications of this market consolidation for the delivery and governance of representative sampling systems. Representative samples underpin the key performance indicators that define processing efficiency. While the feed, products and tailings streams require valid samplers, there are likely to be intermediate streams where representative samplers are also needed. This will only increase as future orebody complexity increases, and hence a true understanding of unit performance within the mineral processing flow sheet will be required. Factors such as equipment performance, process control, and ore variability all influence results; without representative sampling, true performance cannot be measured or optimised.

Maximising plant efficiency requires that sampling system design follows established TOS principles, that maintenance is uncompromising, and that infrastructure allows safe and effective access for inspection, servicing, and verification. Failure to meet these requirements risks generating biased or unrepresentative samples, undermining metallurgical accounting, process optimisation, and ultimately operational profitability.

KEYNOTE: *Uphill both ways: Improving sampling in the field of food and agriculture*

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Evaluation of a Feed Stream Measurement System in a PGM Concentrator Plant using Replication Experiment, Variography, and TSE-Based Sampling Scheme Optimisation

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Reliable metallurgical accounting in Platinum Group Metal (PGM) concentrators depends on representative sampling and reliable assay data. In slurry feed streams, short range measurement system variability frequently dominates total uncertainty. This study evaluates the capability of a feed stream measurement system using an integrated Theory of Sampling (TOS) framework comprising Replication Experiment (RE) for short term precision, variography for long term capability, and variography based Total Sampling Error (TSE) simulation for prescriptive optimisation. The RE delivered Relative Standard Variability (RSV) values of 7.5% (primary), 3.9% (secondary), and 1.7% (laboratory), indicating fit-for-purpose short term precision under controlled operating conditions, with primary sampling as the major contributor to total uncertainty. Variography over six months of 12 hourly feed assays showed a low sill, negligible cyclicity, but a dominant nugget effect (~58% of total variance), revealing that short-range measurement variability governs long term data quality. TSE simulations identified an optimal, operationally feasible scheme of Q = 12 increments at r = lag 1 (estimated TSE ≈ 2.9%), directly targeting the nugget by enhancing temporal coverage and suppressing grouping/segregation errors. Integrating RE for short-term capability (after maintenance or ore blend changes), variography (capability surveillance) for long-term performance assessment, and TSE optimisation (composite increment sampling regime) provides a practical pathway to sustained, fit-for-purpose measurement system performance in industrial process sampling.

Overcoming practical sampling challenges at a PGM smelting operation towards Theory of Sampling compliance and improved quality assurance.

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The Theory of Sampling, although complete in its exploration and mathematical derivation from first principles, does not cover all challenging aspects of sampling unique applications within mineral processing and pyrometallurgical operations. This paper explains the necessary TOS principles that were aspired to allow much improved sampling practices at a Platinum Group Metal (PGM) smelting operation where material properties including temperature, density, brazing, heterogeneity and hardness prevent perfect, theoretical sampling regimes to exist. Improved equipment, methods, procedures and verification of the heterogeneity of each stream is presented for fine granulate material, furnace matte and furnace slag streams. The paper focuses on innovation to align to TOS as best as practical despite applications where full compliance is not viable. The gains in precision and overall improvement of sampling variance (V0) are reported.

Keywords: TOS, sampling of molten material, heterogeneity of batch furnace material, practical sampling.

Session three: Gold

Sampling of Conglomerate-Hosted Nuggety Gold in the Pilbara, Western Australia

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The Archean Fortescue basin, covering much of the Pilbara craton, Western Australia, is host to numerous gold-bearing conglomerate deposits and occurrences. Bouldery gold-bearing conglomerates occur in two stratigraphic positions: 1) resting on the profound basal unconformity with older basement and underneath the Mt. Roe basalt and 2) along para-conformities within the Hardy Formation, a sequence of siliciclastic sedimentary rocks deposited above the Mt. Roe basalt. Gold-bearing conglomerates often display strong lateral continuity suggestive of broad-scale depositional processes, likely transgressions of the sea. Gold occurs predominantly as coarse nuggets, often flattened and folded, an indication of a water-worn history. Nuggets range from a few hundred microns to a few centimeters across and generally occur within sandy matrix material, sometimes with detrital pyrite. Vertical and lateral distribution of nuggets within a conglomerate layer can be highly erratic making sampling challenging. Appreciable disseminated fine-grained (<100 micron) gold is present in some conglomerates (e.g. Beatons Creek), whereas it is scarce in some basal conglomerates, especially at Karratha where fine-grained gold is restricted to very thin halos around gold nuggets. To evaluate gold grades at its various conglomerate gold projects, the operator had to develop specialised protocols for sampling, processing and analysis suited to each deposit. At Karratha, where gold is extremely coarse, multi-tonne bulk samples were collected from 2 x 2 m sub-horizontal panels with a minimum thickness of 0.3 m. Grades from these samples based on a dedicated pilot scale were considered indicative. A 1,000’s t scale bulk sampling programme was deemed the best means to further evaluate grade of the mineralization. Testwork of mechanical rock sorting utilizing X-ray transmission and electromagnetic induction to identify gold-bearing rock particles was promising.

Core Saw Sampling: an in-field, rapid alternative for gold and multi-element analyses of drill core samples.

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1Portable PPB

Diamond drilling is used extensively in mining exploration for the collection of contiguous core samples. These cores are typically broken into ~1m lengths and transported from the drill site to a core shed to be cut longitudinally prior to being sent off for further examination, preparation, analysis and/or archiving.

The swarf cuttings from the core saw are considered waste; flushed away by cooling water or accumulating in the sump tray of the saw. This paper demonstrates how the cuttings may be collected, prepared and analysed for gold using detectORE(tm) and multi-element grades using XRF.

Test work is presented to validate that the method produces representative and contamination-free results, and enables significant benefits in turnaround time.

This method allows in-field sample analysis, enabling accelerated mineral exploration at a far lower cost than conventional analysis.

Direct Measurement of Laboratory Sampling Precision in Gold Ores: A Complement to “Gy's Formula”

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Gy's Theory of Sampling (TOS) by way of the Sampling Nomogram provides a rigorous framework for estimating sampling precision in particulate materials. However, its practical application requires estimation of parameters describing particle size, liberation, shape, density and clustering, introducing significant uncertainty into predictions.

We present a complementary experimental approach in which laboratory sub-sampling precision is measured directly rather than inferred from a theoretical model. The method applies to all laboratory operations following the critical primary field or mine sampling.

Using a unique database of non-destructive replicate analyses from more than thirty diverse gold operations, identical samples were measured before and after successive stages of laboratory comminution. This allowed laboratory sub-sampling precision to be quantified under real-world conditions without relying on estimated sampling parameters. The resulting database is one of the largest empirical studies of its kind.

Comparison with precisions estimated using the conventional sampling nomogram approach shows that reductions in sub-sampling variance with decreasing particle top size are frequently much smaller than predicted. While some ores benefit substantially from additional comminution, many show only modest improvements, indicating that the value of pulverisation is strongly deposit dependent. Direct experimental measurement therefore provides a practical basis for optimising laboratory sample preparation workflows.

The measured variances also enable estimation of the effective number of gold particles (NEFF) contained in each sample. Combined with sample mass and grade, this yields an experimentally derived effective gold particle size, providing new insights into various types of gold ore heterogeneity, comminution effectiveness and the geological controls on laboratory sub-sampling behaviour.

This experimentally validated framework complements the TOS, providing a practical, experimentally validated basis for evaluating laboratory preparation strategies and optimising analytical precision using modern large-aliquot, non-destructive techniques such as PhotonAssay™.

A Robust Sampling and Quality Management Framework Enabling MILP Production Optimization at Sukari Gold Mine

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At the Sukari Gold Mine, maintaining rigorous metallurgical feed quality is paramount to optimizing blending and production outcomes. This operational stability is governed by strict sampling protocols and established quality streams performed under a proactive Quality Management framework to ensure optimized decisions based on known quality and representativeness data.

Within the controls implemented, the main error contributor to total sampling error—sample collection—has been strengthened with the implementation of a series of proactive controls: monthly bias tests are consistently performed across the RC rigs to monitor sample representativeness during sample collection, and sample weight is monitored right next to the rigs to evaluate the drilling process, including recovery and the implementation of the sampling protocol.

In terms of Grade Control, ore is concurrently sourced from both Underground (UG) and Open Pit (OP) operations, discharging into distinct stockpiles categorized by specific grade ranges. Each stockpile is defined by its opening physical tonnage and weighted average gold grade. To navigate this operational complexity, daily mining plan inputs—introducing fresh material—are integrated alongside variable daily crusher capacity constraints. The core objective is to determine the mathematically optimal crusher feed blend that satisfies daily mechanical limits while consistently achieving the weekly recovered gold ounce target.

To solve this multi-variable challenge, this paper presents how robust Quality Management in sampling can support enabling a dynamic Mixed-Integer Linear Programming (MILP) optimization model. By mathematically formalizing stockpile mass balances, grade variability, geometallurgical recovery rates, and crusher throughput limits over a multi-period rolling horizon, the model replaces reactive, rule-of-thumb blending with predictive decision-making.

Ultimately, the proposed framework demonstrates how bridging rigorous Quality Management protocols with advanced mathematical programming minimizes feed grade variance, prevents crusher bottlenecks, and guarantees weekly gold production targets.

Thursday 26 November
Session four: Environment & Recycling

From Accepted Practice to Sampling Reliability: Challenges in introducing TOS into Environmental Site Assessment

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The Theory of Sampling is well established in the mining sectors, where the consequences of poor sampling have long been recognized. In mining, sampling errors are often revealed through financial loss, grade reconciliation, and production control. In environmental site characterization, by contrast, decisions tend to rest on accepted guidance, professional judgment, regulatory compliance, and laboratory quality assurance, without necessarily making sampling uncertainty explicit. As a result, this primary source of uncertainty often remains insufficiently addressed, with direct implications for decision reliability and for the risks carried by stakeholders.

The growing use of Incremental Sampling Methodology in the United States, and more recently in China, shows that this is beginning to change. Still, TOS has not yet become part of the normal language of environmental site assessment in most jurisdictions across the world. Decisions continue to be made on highly heterogeneous materials and large volumes of soil or fill, using analytical results obtained from very small test portions, often without explicitly addressing the sampling process across these scales.

This presentation draws on ongoing work carried out in Québec, Canada, to modernize practices for the characterization of contaminated sites. Rather than reviewing the basic principles of TOS, it focuses on the difficulties of introducing them in a field where sampling is often taken for granted. Key issues include limited attention to sampling uncertainty, the dominant role of discrete samples, concerns that compositing may hide localized contamination, the overlap between detection, classification, and estimation objectives, and the regulatory and professional contexts that make established practices difficult to change.

The main challenge is therefore not only technical, but also cultural and institutional. Bringing TOS into environmental site characterization requires translating it into the practical language of environmental decisions, regulatory compliance, risk management, and professional responsibility.

Sampling of End-of-life Batteries for Recycling

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The energy transition requires the increasing use of batteries, however they have a limited lifespan. Given that they contain critical materials, their recycling is essential. This secondary resource is growing rapidly. However, their composition is not well understood, as detailed traceability is not yet the norm. The same applies to the recycling of battery production scrap, which is classified as such because it does not meet the required composition standards. This is why measurement by sampling and analysis remain a crucial step in the recycling process.

Sampling entire modules, cells or even electrode scraps is inherently difficult, subject to significant uncertainty and incurs high analytical costs. The value of this secondary resource can only be estimated indirectly, based on sampling the outputs of mechanical pretreatment such as MTB's Zero Waste Battery process.

A lithium-ion battery consists of cathode, anode, separator, electrolyte, current collectors, cell container, module casing, connectors, control circuit board and cooling system. During shredding, the components are liberated to varying degrees and particle sizes. They can be separated according to their physical properties by particle size classification or density separation, for example. The main products are electrolyte condensate, black mass (cathode and anode active materials), copper, aluminium and plastic foils.

The heterogeneity of these different materials, due to imperfect separation and the variety of technologies and states of degradation of the batteries, has been studied in order to estimate the sampling error and develop correct sampling techniques whilst ensuring the health and safety of operators. This article describes this heterogeneity, the calculation of the fundamental sampling error, sampling strategies, preparation protocols and the various analytical techniques enabling the characterisation of recycled products, whether for their end-users or to back-calculate the initial composition.

Size-Grade Heterogeneity and Fundamental Sampling Error in Milled Autocatalysts: Implications for PGM Recycling Practice

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Milled spent automotive catalysts are a major secondary source of platinum group metals (PGMs), but they remain difficult materials to sample reliably. Unlike many natural ores, autocatalysts are manufactured composite materials in which the valuable metals are associated with a washcoat attached to a ceramic or metallic substrate. During milling, this structure can generate pronounced size-grade heterogeneity meaning that different particle-size fractions carry significantly different concentrations of PGMs.

This presentation examines how assay-by-size data from multiple milled autocatalyst lots can be used to connect sampling theory with operational practices in an industrial setting. The focus is on understanding how observed size-grade heterogeneity should influence the way Fundamental Sampling Error (FSE) is estimated and interpreted.

The data show that the calculated minimum sample masses required for these materials vary considerably depending on the batch, and some are notably greater than typically assumed in routine operations. Practical applications discussed include selecting more defensible minimum sample masses, appropriate splitting and mass-reduction steps, and improving representative sampling for this high-value and important recycling feed.

Session five: Plants & Concentrates

Ways-and-means to get the advantage over opponents in minerals mining, trading and refinement settlement agreements – if your opponent is not smarter than you

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I here describe use and misuse of the Assay Exchange paradigm and other initiatives for the prospect of one-sided economic gain - if settlement transaction opponents are not 'smarter' than you. There are several technical issues that need to be manipulated, together with various ‘on the ground’ dishonest practical practices, before such malevolent advantages can be effectuated. These shady possibilities all have the same objective: asymmetric economic advantage for one of two settlement stakeholders if your opponents are not the ‘smarter’ ones. I here elaborate and discuss this fascinating hinterland of the business surface of minerals mining, refining, trading a.o. I also focus on opportunities for increased profitability by ‘tuning’ assaying and trying to bend the arm of risk mitigation, as there are many tempting opportunities for devious behaviour and lack of due diligence along the full ‘lot-to-analysis/assaying-to settlement’ pathway, ranging from ill-informed negligence to will-full fraud. However, while there assuredly are some deliberate bad actors out there, acting in bad faith, many of the deceptions and manipulations revealed here, by other parties these are often considered as legitimate business options. Be this as it may, the resulting effect is the same: one of the parties will suffer an induced, unwanted economic loss of unknown magnitude. How can this be justified? I conclude with encouraging to subscribe to what can be done, indeed what should be done to rectify this problematic state-of-affairs. Perhaps not surprisingly, this involves being true to the Theory of Sampling (TOS) everywhere and everywhen sampling (including sub-sampling) is on the agenda - together with a call for honesty in TIC (Testing, Inspection, Certification), helped by a clarion call for moral re-armament in these severely challenged industry sectors.

Variography Applied to Sampling a Carbon-In-Leach (CIL) Plant

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Understanding gold extraction from ore in a Carbon-In-Leach (CIL) plant is challenging in view of the variability in properties of ore fed to the plant, the complex interaction between mineralogy, reaction kinetics and hydrodynamics in the CIL tanks, the effect of flow and cyanide dosage adjustments, and uncertainty associated with monitoring the process through sampling. The combined effect of these factors was observed during a sampling campaign conducted in an operating CIL plant for 209 consecutive days. Analysing temporal variation in the gold grade in the solid (ore), liquid, and carbon phases reveals the classic variogram shape which can be characterised with three parameters: the nugget, sill, and range. Of these, the nugget expresses the combined effect of sampling and short-range temporal variability. For the gold grade in the solid and solution phases, the ratio of nugget and sill progressively increases across the tanks. This is consistent with a process which produces a 'funnel' graph in which grade and grade variability decrease while the sampling error remains roughly constant. For the carbon phase, which moves counter-currently to the solid and liquid phases, an opposite trend in the nugget-to-sill ratio across the tanks is observed. This may be ascribed to the uniform quality of activated carbon entering the plant, its relatively long residence time, and the 'sponge'-like effect of carbon for absorbing variation in the concentration of dissolved gold. The study suggests that variography can support the characterisation of time series of 'noisy' sample data and potentially provide recommendations for sampling design and plant control.

Is TOS Knowledge Homogeneously Distributed? A Manufacturer's Field Report

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1Iteca Socadei

The goal of a sampling equipment manufacturer is to propose, sell, manufacture and install solutions that match the client's requirements and meet their expectations.

To do this, the need must be clearly identified and analyzed from the start of the project, and it must be well known, understood and validated by the client. Any misunderstanding or poor knowledge can lead to important technical and/or financial impacts.

This requires a minimum knowledge of the Theory of Sampling (TOS) from all parties involved: the client (both technical and financial sides), the in-between stakeholders (project management, engineering firm, purchasing department and so on) as well as, of course, the manufacturer.

But is this knowledge really “distributed homogeneously” among the different stakeholders?

It is often present in companies that already use representative sampling solutions, but not always. Unfortunately, in many other cases, TOS remains unknown, not only to the end user, but also to decision-makers, and even to the engineering company in charge of the project.

In addition, the path from expressing a need to installing and using a sampling solution is full of pitfalls, and these are not always easy to avoid. There are many cases where the installed equipment does not perform as expected or, in the worst-case scenario, is not suitable for the intended purpose. It is worth exploring the causes, which are often multiple.

This paper presents a collection of real cases from the last few years, together with the consequences they had for the plant operators. It tries to identify the single or multiple causes behind each case, and to suggest the measures that could have prevented them.

Brownfields replacement of a non-probalistic, stationary 5-cutter device with a TOS compliant launder sampler system; novel variographic quantification of the sampling improvement on a copper flotation product stream

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1Multotec Process Equipment

Stationary 5-cutter samplers (S5CS) are non-probalistic devices that partially “sample” only an overflow component of a slurry stream - and not the baffle underflow component - thereby preferentially sampling the fine, light particles resulting in bias samples. Slurry properties including viscosity, density, percentage solids, particle size distribution, the presence of flotation activators will all affect the sample extracted by stationary cutter devices and the sample quality falls victim to the inconsistent slurry rheology which is bias and will be variable. Launder crosscut and Vezin samplers follow Theory of Sampling (TOS) principles to delineate an increment from the entire stream and allow all particles equal probability of being selected and preserved. The cross-stream samplers are equipped with a sufficient cutter proportion to sample the stream fully, irrespective of distributional heterogeneity or stream properties. This paper quantifies (for the first time) the variographic comparison results after replacement of a non-probalistic S5CS with a TOS compliant, launder system on a copper flotation final concentrate stream.

Bias elimination and factor two variance improvements are achieved by the launder crosscut system, now providing representative samples for control, governance and decision making.

Keywords: TOS, stationary cutter sampler, bias elimination, precision and standard deviation improvement, probalistic sampling.

Friday 28 November
Session six: Open

KEYNOTE: Is the Mining Industry Really Prepared for Artificial Intelligence?

The Enabling Role of Quality Management for Representative Samples and Data...

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Representative sampling of dense powder/granule streams for inline PAT prediction of Blend Uniformity

Giovana Teixeira[1]***, Manuel Kuhs***[1]

1Expo Process Analytics

In pharmaceutical oral solid dosage manufacturing, Blend Uniformity (BU) is increasingly being predicted in real-time using inline spectroscopic measurements, especially in continuous tabletting. However, where BU is desired prior to the tablet press, direct insertion of PAT probes into power/granule streams faces significant challenges: material flow irregularities including air gaps and pulsing lead to highly noisy spectroscopic baselines, and small spectroscopic spot sizes relative to the material stream cause non-representative sampling.

We present an inline probe interface that attempts to overcome both shortcomings by placing a sampling wheel directly into the sample stream and in front of a Near Infrared (NIR) probe window. As a control, we remove the sampling wheel. The APAP blend stream is randomly sampled (as confirmed by Theory of Sampling calculations outlined in DS 3077:2024) and presented as a well-formed, consistent powder/granule bed to the probe for continuous measurement. As a result, the spectroscopic baseline and signal-to-noise ratio are significantly increased against the control, and the PLS model and consequent BU prediction performance are increased by over 40%.

Real Time Sampling and Analysis of Pharmaceutical Powder Blends At Kilograms per Hour

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An interface for obtaining real time NIR or Raman spectra was designed following the principles of the Theory of Sampling, patented and is now commercialized as the Stream Sampling Kit (SSK). The SSK makes it possible to sample and analyze pharmaceutical powder blends as they flow at > 30 kg/hour[1,2]. The drug concentration has been used to develop variograms, making it possible to estimate the sampling and analytical errors and decouple these from the variance of the pharmaceutical powder blend [3].

The determination of drug concentration in flowing powder blends has required overcoming the effects of physical properties on NIR spectra. The studies also required understanding the effect of blend heterogeneity on calibration models.

Acknowledgements

The funding of the Puerto Rico Science Technology and Research Trust (2024-00182), the Economic Development Administration (01-79-14889), and America's Seed fund SBIR.STTR by the National Science Foundation (SBIR Phase I Award ID:1621688) is acknowledged.

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Session seven: TOS Education

Theory of Sampling (TOS) – Introductory Interactive Infographic

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The Theory of Sampling (TOS), founded by Pierre Gy in 1950 and further developed during the following 75 years, has shown its powerful general applicability. From the original focus on the mining and minerals processing sectors (incl. production of cement), it is today successfully applied in very many other industrial sectors and domains where valid sampling is a prerequisite for reliable process monitoring and decision-making, includes food, feed and agriculture, process quality control systems, as well as sampling of various modern recyclates, pharmaceuticals, environmental monitoring (list not exhaustive).

Decisions based on analytical data characterising heterogeneous materials are only as good as the samples and sub-samples they are based upon. TOS, together with risk management, is therefore the critical success factor in industrial and business decision making and its role cannot be underestimated: TOS provides the world's only necessary-and-sufficient, complete framework to solve all salient sampling issues critically addressing the adverse effects caused by heterogeneity.

TOS' universal relevance is well documented in the pertinent scientific literature, but is still not sufficiently known and applied in all societal sectors, partially because of lack of awareness and partially because of the complexity of TOS' theoretical framework that too often is claimed to scare away potential new users.

We have developed an interactive infographic with the intent to help easy access for newcomers and practitioners to TOS' basic concepts, terminology, principles and practical unit operations. This contribution presents the development the TOS Infographic and intends to go in the lead answering the challenging question:

How best to introduce TOS to newcomers?

The power of education and wide understanding of The Theory of Sampling

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Process grade control is an essential part of quality assurance and quality control (QA/QC) in order to assure high quality final products in many process industries. Representative sampling is a prerequisite for reliable analytical results and analytical validity can never compensate for incorrect sampling practices. While many industries prioritize considerable resources in laboratory accreditation, analytical instrumentation, competence and quality control, the attention on representative sampling and preparation procedures often receives comparably less attention. Many studies in mining and processing operations indicate that sampling contributes with a significantly higher variability than the analytical methods, even as much as 90% of the total variability.

Routine process sampling is most often performed by shift-working operators and technicians, lacking formal scientific education. Even with detailed instructions and well-defined procedures in place, manual sampling and preparation are prone to errors when the underlying principles are not fully understood by those performing the various tasks. To address this challenge, LKAB has developed and implemented a sampling course based on the fundamental principles of the theory of sampling, accessible to both engineers and operational sampling staff. The objective has been to provide an understandable and applicable combination of theory and practice for correct sampling principles, supporting operators to make correct decisions and apply methods that minimize sampling errors in all sampling and preparation operations within the iron ore process chain. By linking theoretical concepts such as heterogeneity, segregation, representativity and sampling errors to real sampling situations, the course aims to create a wider understanding of basic sampling principles across different professions. The improved common understanding for sampling theory has improved communication, increased the possibilities for continuous improvements within sampling and preparation operations and strengthens the organizational focus on representative sampling as a critical element of process and product quality control.

Simple sampling: understanding the logic with no math

***Claudia Paoletti*[1], *Oscar Dominguez*[2], *Jean-Sébastien Dubé*[3]**

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Johannesburg, May 2024: while attending WCSB11 Claudia Paoletti (biologist), Oscar Dominguez (geologist) and Jean-Sébastien Dubé (civil engineer) were wondering how to effectively support those who have limited or no understanding of sampling but want to learn more about it. Initially, we were unsure how to best combine our different backgrounds to achieve such wish. However, it did not take long to realise that the different perspectives with which we approached sampling during our careers could be exploited to facilitate the appreciation of sampling universality and materialise into a book to get a first smattering of the principles and logic framing the Theory of Sampling (TOS). Our driving challenge was to write such a book without diving into complex mathematics as we were (and still are) convinced that TOS can be understood without formulas. Sampling is a transversal discipline, encompassing sectors' boundaries and deserving global recognition, understanding and interpretation. Often, too often, TOS mathematical complexity scares away those in need of sampling to take informed decisions. The consequence is an intricate plethora of sampling procedures, based on unverified distributional assumptions that cannot document representativity and therefore are useless. If we think about the volume of decisions taken across all sectors worldwide that would have needed correct sampling to be informed, we get frightened imagining the high price the world is paying.

Our book is the first publication providing a synthetic math-free TOS overview, dedicated to beginners as a quick reference manual. Its objective is to accompany the reader on a journey to gain the necessary basis to understand what correct sampling is about and how to apply it, without taking anything for granted. The first edition will be published in the coming months. We look forward to presenting our work and collect input from WCSB12 audience to fine-tune our undertaking.

Session Eight: Pharma & Agriculture

KEYNOTE: Theory of Sampling for Quality Medicines

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In most industries, sampling involves the physical extraction of material from a process. A company could have a process with a fixed drying time of eight hours to bring material to a required 4% (wt/wt) moisture content. Samples would be brought to a Quality Control laboratory at the end of the required eight hours for analysis by a chemist. However, it is also possible to analyse materials in real time during the unit operations of a manufacturing process, without bringing samples to the Quality Control laboratory. These real-time analyses could show that the material was at the required 4% (wt/wt) moisture content after only two hours of drying. The drying process could then be stopped after two hours, resulting in time and energy savings for the company. This concept of designing, analysing and controlling processes with real-time analysis to improve the quality of a product is now known as Process Analytical Technology (PAT) [1].

Sampling always occurs before the real-time analysis performed in PAT [2]. All parts of a lot must have the same opportunity of being selected for these real-time measurements. Composite sampling is also essential for the success of PAT [3].

The United States Pharmacopeia (USP) is now coordinating the efforts of an Expert Panel to develop a new General Chapter on PAT. The USP is a non-profit organization with a mission “to improve global health through public standards and related programs that help ensure the quality, safety, and benefit of medicines and foods” [4]. The PAT General Chapter will provide comprehensive and practical guidance aligned with current scientific and regulatory standards, for the implementation of PAT within the pharmaceutical industry. The PAT chapter will be an informational describing scientific background and recommended practices. The USP standards are used in more than 150 countries and play a critical role in supporting the quality of medicines used by billions of people worldwide.

The Theory of Sampling has been part of the discussions of the USP Expert Panel on PAT. A Stimuli article seeking public review and comment on the Theory of Sampling in PAT was prepared and published by USP [5]. Stimuli articles are used by USP to seek public review and comment on potential standards and related scientific topics, helping to inform and guide possible future compendial activities.

This presentation will discuss the recent Stimuli article [5] and the importance of the USP Expert Panel. The Theory of Sampling is emerging as an important scientific foundation for the development of PAT standards that support process understanding, representative measurements, and the consistent manufacture of high-quality medicines.

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Characterizing within- and between-plant variability of mycotoxins in barley

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Fungal secondary metabolites (mycotoxins) have the potential to impact health if consumed at high enough levels and are therefore an important consideration in the production of grains, including barley. Deoxynivalenol (DON) is a commonly occurring mycotoxin in grains, and its presence in barley is managed by use of strict industry specifications. Barley cultivars generally carry an intermediate level of resistance to fungal infection, resulting in a limited number of infected kernels on a barley spike. Coupled with micro-environmental variations in a field, these biological and environmental factors can lead to a heterogenous distribution of DON, and other mycotoxins in the field as well as in bulk harvested grain.

Malting-relevant barley varieties were grown in 2021 and 2023-2025 under common agricultural practices with enhancement of infection using inoculated grain deposited on the soil surface during plant heading. The distributions of DON and other mycotoxins were characterized within different frames of reference, including kernel-to-kernel, spike-to-spike, plant-to-plant, and year-to-year frames.

DON was one of the most frequently observed mycotoxins in the kernels, spikes, plants, and field samples in the four years of the study. The frequency of occurrence changed with frame of reference; for example, 13%, 39%, 100%, and 100% of kernel, spike, plant, and field samples, respectively contained DON. The widest range and highest concentrations were observed in kernels, with the narrowest range in field samples. The range for DON and related mycotoxins decreased from kernel to spike, to plant, and to field samples, as the infrequently occurring infested kernels were combined with sound kernels, and mycotoxins subsequently diluted, in these larger samples.

Extending Variables Acceptance Sampling Beyond Normality: Beta Plan Design for Food Quality

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1Auckland University of Technology

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Variables acceptance sampling (VAS) is an established tool for industrial lot inspection, with ISO 3951-1:2022 specifying plans for quality characteristics that are Normally distributed or closely approximated by Normality. This assumption is restrictive for food-quality measurements that are bounded, asymmetric, or concentrated near a specification limit. Beta-based VAS accommodates these features and can require fewer observations than Normal-based plans under equivalent risk constraints; however, its adoption has been limited by the absence of convenient plan-design methods

and software, particularly when the Beta precision parameter is unknown. We address this gap through a unified computational framework for known- and unknown-precision Beta VAS. The framework provides practical plan-design tools for both cases and uses simulation to evaluate their performance. An application to food-quality measurements illustrates the practical use of the framework. The methods are implemented in AccSamplingDesign, an R package for designing, evaluating, and visualising acceptance-sampling plans. This work complements representative material sampling by providing a reproducible statistical rule for deciding whether a production lot should be accepted from the resulting measurements.

Acceptance sampling plans for food in the case of heterogeneous bulk materials

Bertrand Colson*[1]*, *Steffen Uhlig*[1]

1QuoData GmbH

Acceptance sampling for contaminants such as mycotoxins rests on an implicit assumption about how contamination is distributed within a lot. When contamination is concentrated in a small fraction of the material rather than spread evenly, and when the lot is acceptane or rejected based on one test result from one composite sample—and the probability that a sampling plan accepts such a lot depends critically on this heterogeneity.

We present a model that characterises this heterogeneity using easily interpretable parameters: the proportion of contaminated increments, and the distribution among contaminated increments. An extended version adds a fourth parameter describing how contamination levels vary from lot to lot. Because increments are combined into composite results before measurement, the within-lot distribution must be reconstructed indirectly; we show that this is achievable from existing aggregate monitoring data, and we show results from the application of the model to official-control and export-testing datasets.

The fitted parameters translate directly into the probability that a given sampling plan accepts a non-compliant lot, allowing realistic, data-driven evaluation of existing sampling plans. Moreover, on the basis of such parameters, a novel utility approach has been developed translating to transparent, well-founded decisions regarding the sampling plan itself (number of increments, etc.).

Session Nine: Process Sampling

Do we need to sample Process Water?

Reinaldo Novaes*[1]*, *Michael Hidding*[1]

1FLS

The sustainable use and preservation of water is critical to the future of humanity. All human activity consumes water—from personal use to large-scale industrial processes—and the mining industry is no exception. In regions where water availability is low, mining operations increasingly rely on water reuse and recycling, particularly within mineral processing circuits.

However, water reuse in mineral processing—especially in flotation and preceding stages—presents significant challenges. A key issue is the progressive accumulation of dissolved and suspended "contaminant" elements in recycled process water, which can adversely affect process efficiency, product quality, and overall economics.

This paper presents a literature-based review of current practices in water reuse and recycling within mineral processing, highlighting the technical and economic impacts of using reclaimed water. Importantly, it highlights the often-overlooked importance of properly sampling recycled process water to enable further study of the technical aspects and impacts of these practices. Accurate and representative water sampling is essential for process monitoring and control, enabling better decision-making, improved process performance, and reduced variability in product quality. Furthermore, effective sampling strategies can help identify potential cost implications linked to water reuse, supporting more sustainable and economically viable operations.

A Practitioner's Primer on Correct Sampling in the Minerals Industry: From Protocol to Audit

Richard Minnitt[1]

1University of Witwatersrand

A Sampling Practitioner's Primer is a working guide to Pierre Gy's Theory of Sampling, written for the geologists, metallurgists, QA/QC managers, and auditors whose sign-off turns a handful of grams into a mine plan, a shipment grade, or a court-defensible number. Co-authored by Richard C.A. Minnitt, Kim H. Esbensen, and Martin Lischka, the book draws together decades of academic derivation, industrial audit experience, and cross-sector teaching into a single practical reference, grounded throughout in real economic case studies rather than theory alone. Beginning with the money at stake in a sampling decision, and the reconciliation failures that signal when it has gone wrong, the book works methodically through the full lot-to-aliquot pathway: the language and history of the discipline; Gy's formula for the Fundamental Sampling Error and the long-debated liberation factor; the Grouping and Segregation Error; correct delineation, extraction, and preparation; weighting and error integration; and the equipment specification, sampling audit, and standards frameworks — including DS 3077 and the commodity-specific ISO codes — that turn theory into defensible practice. Later chapters extend the discipline beyond mining into process industries, variography, and continuous process control, closing with the business case for winning executive commitment to correct sampling. Throughout, the book states plainly where the theory is settled and where it remains a live discipline, flagging genuine open questions — including the historical confusion around the liberation factor, now substantially reconciled — rather than presenting the field as closed. Worked examples drawn from gold, iron ore, and copper operations, practice notes at the end of every chapter, and a consolidated glossary and symbol table make each chapter usable as a standalone reference. The result is a primer rigorous enough for the specialist, current enough for the researcher, and accessible enough for the practitioner meeting the theory for the first time — a book for the desk, not the shelf.

SRS – Sampling Reduction System / SRM - Sistema de Reducción de Muestra

***Pablo Villaroel*[1], *Alexander Kaercher*[2]**

1Tecpromin S.A

2MSC – Mineral Sampling Consultant

Introduction:

Many users have encountered some of the following issues with secondary and/or tertiary Vezin slurry samplers?

Related to the Theory of Sampling (TOS):

- Pulsating feed from the secondary Vezin sampler to the tertiary sampler.
- Solids segregation in the drop/feed stream from the secondary to the tertiary sampler.
- Sample mass too small to feed the Vezin sampler while complying with the required number of increments (sub-samples).

Safety and Health Aspects:

- Sampling equipment installed at high elevations inside the concentrator plant, featuring restricted or limited access for inspection, equipment cleaning, and/or maintenance. Complex routes to transport the final sample, including numerous and sometimes even vertical stairs.

Operational Challenges:

- The final sample mass can weigh up to 15 kg (or more) per shift, and the entire mass must be filtered, dried, reduced, and pulverized to reach a final analytical sample mass of approximately 150 grams for chemical analysis.

Description:

The SRS achieves a continuous feed rate to the subsequent sampling stage, along with a high sampling frequency.

The SRS is a new system that guarantees a significantly higher number of increments compared to existing systems. The total sample mass per shift and/or defined time period is substantially lower than that of conventional systems.

The SRS complies with the Theory of Sampling (TOS) and beyond.

The SRS is designed to be installed at ground level in the concentrator plant, providing maximum flexibility in layout and placement. This improves access for cleaning, maintenance, operational supervision, and final sample collection at the concentrator plant.

The SRS is engineered as a single integrated skid unit, including support structures, access platforms, piping, and electrical conduits as part of the scope of supply.

Advantages:

- A higher number of sampling increments results in more representative samples and more reliable analytical results.
- High number of increments and lower total sample weight (per shift). This translates into reduced handling time and effort to deliver the final sample to the chemical laboratory for analysis.

- Shorter sample turnaround time per shift, requiring fewer reduction steps (and thereby minimizing cumulative error introduction).
- Ground-level installation in the concentrator plant enhances access for supervision, maintenance, and sample retrieval.
- Adaptable to plant throughput, with the ability to integrate seamlessly as a feed system for any existing online analyzer.
- Customizable to client requirements, allowing the SRS to also collect spot/grab process samples.
- Single integrated unit design, simplifying engineering, installation, and site integration.

POSTER PRESENTATIONS

Field Duplicates as a Tool to Evaluate Sampling Uncertainty and Its Effect on Ore Classification in an Ag–Pb–Zn Epithermal Vein Deposit.

Claudia Nalleli Ortega Santillán

1SIG-Independent Geological Consultant

Sampling uncertainty is one of the main sources of variability affecting the evaluation and classification of mineral resources. Although field duplicates are routinely included in Quality Assurance and Quality Control (QA/QC) programs, their interpretation is generally limited to assessing sampling precision through statistical reproducibility indicators. This study investigates the potential of field duplicates to experimentally evaluate the integrated variability of the sampling workflow and to examine how this variability propagates into ore classification decisions in an Ag–Pb–Zn epithermal vein deposit.

A total of 94 pairs of original and field duplicate samples collected during grade control activities were evaluated. Sampling reproducibility was assessed using the Hard Absolute Relative Difference (HARD), Relative Percent Difference (RPD), and Bias. The effect of sampling variability on economic classification was evaluated using a cutoff grade of 140 g/t AgEq.

The results showed that 16% of the duplicate pairs changed their economic classification between ore and waste, with waste-to-ore transitions being the most frequent. Reclassified pairs exhibited significantly higher HARD and RPD values, indicating that greater sampling variability increases the uncertainty associated with material classification, particularly for samples with grades close to the economic cutoff.

The results demonstrate that field duplicates provide information that extends beyond the conventional assessment of sampling precision. Their combined interpretation with ore–waste reclassification offers a practical approach for evaluating how the integrated variability introduced during sampling, sample preparation, and analytical measurement propagates into economic classification decisions. This approach complements conventional QA/QC programs by providing additional evidence to support confidence in ore classification and mineral resource evaluatio

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A Sampling Practitioner's Primer is a working guide to Pierre Gy's Theory of Sampling, written for the geologists, metallurgists, QA/QC managers, and auditors whose sign-off turns a handful of grams into a mine plan, a shipment grade, or a court-defensible number. Co-authored by Richard C.A. Minnitt, Kim H. Esbensen, and Martin Lischka, the book draws together decades of academic derivation, industrial audit experience, and cross-sector teaching into a single practical reference, grounded throughout in real economic case studies rather than theory alone. Beginning with the money at stake in a sampling decision, and the reconciliation failures that signal when it has gone wrong, the book works methodically through the full lot-to-aliquot pathway: the language and history of the discipline; Gy's formula for the Fundamental Sampling Error and the long-debated liberation factor; the Grouping and Segregation Error; correct delineation, extraction, and preparation; weighting and error integration; and the equipment specification, sampling audit, and standards frameworks — including DS 3077 and the commodity-specific ISO codes — that turn theory into defensible practice. Later chapters extend the discipline beyond mining into process industries, variography, and continuous process control, closing with the business case for winning executive commitment to correct sampling. Throughout, the book states plainly where the theory is settled and where it remains a live discipline, flagging genuine open questions — including the historical confusion around the liberation factor, now substantially reconciled — rather than presenting the field as closed. Worked examples drawn from gold, iron ore, and copper operations, practice notes at the end of every chapter, and a consolidated glossary and symbol table make each chapter usable as a standalone reference. The result is a primer rigorous enough for the specialist, current enough for the researcher, and accessible enough for the practitioner meeting the theory for the first time — a book for the desk, not the shelf.

Teaching Sampling – It's Not That Simple!

Stephane Brochot[1]

1CASPEO

There are two ways to carry out sampling. Either by applying methods that seem to come from an ancient grimoire of magic, or by trying to understand what actually happens when a sample is taken to represent a batch of material. It is the first approach that is, unfortunately, the most widespread. But it is, of course, the second that allows for a reasoned approach, attentive to all phenomena that could hinder correct sampling.

However, this understanding requires learning based on scientific concepts at the intersection of mathematics, physics, composite materials science, mineralogy, process engineering geology, to name but a few. Added to this is the experience—both theoretical and sensory—of the materials to be sampled.

When it comes to teaching sampling to university students, they may still have some vague memories of their statistics or physics lectures, but it is above all practical experience that they lack. In continuing professional development, learners have more experience, but their studies are a distant memory, and their grasp of the fundamentals has eroded. It is therefore quite clear that these two groups cannot be approached in the same way. Some concepts that appear simple require further exploration in order to be properly understood. Moving back and forth between mathematical abstraction and the reality of phenomena is necessary but requires careful attention to learners' understanding.

This article focuses primarily on the author's experience as a university lecturer and corporate trainer, and the various techniques he has employed in an attempt to convey the knowledge required for a sound understanding of the sampling process. It also aims to convey the fascination and curiosity that this craft—in the traditional sense of the word—can inspire.

Performance analysis of the BX-LXD Linear Cross Splitter for productive and efficient representative sample division.

Steven Denis Russell*[1]*, *Matthew Coleman*[1]

1Portable PPB

Splitting is a key step in most sample preparation methods, enabling a larger mass to be subdivided into two or more representative sub-samples (such as a 'sub-sample' and 'retain' splits). Riffle splitters are a convenient way to achieve a fixed split (typically 50/50), and rotary sample dividers result in multiple segments (such as four or eight way splits).

However, for increased versatility in a compact form, a linear sample divider with a sample cutter moving at constant speed through a falling steam provides superior performance.

Linear sample dividers are programmed to achieve either a target split ratio or a target split mass. The latter means improved downstream sample preparation – creating consistency from what is often a highly variable input sample mass – without introducing bias.

For samples containing larger particle sizes, linear dividers also offer a much smaller footprint than riffle or rotary splitters would normally require.

Linear dividers can also be programmed for duplicate flexibility, allowing for an optional duplicate split as required (such as for QA/QC purposes).

Linear dividers have one potential drawback; dead-zones in the achievable splitting ratios due to the mechanical/kinematic limitations of the linear axis motion. Some sub-sample/duplicate/retain ratios may not be possible within a given input mass range. The BX-LXD linear splitter overcomes this limitation, achieving representative sampling across a complete range of splitting ratios.

This paper analyses the performance of the BX-LXD splitter across 3 key metrics:

(1) sub-sample representativity (geometrically and chemically),

(2) cross contamination between samples

(3) target sub-sample mass precision/accuracy.

Best practice sample preparation by sieving; fit-for-purpose methods for in-field exploration sampling.

Steven Denis Russell*[1]*, *Christopher O'haire*

1Portable PPB

Sieving is commonly used in the collection of mineral exploration samples. Sieves are lightweight, inexpensive, and easily transported across expansive field campaigns for soil samples, stream sediments, etc.

By definition, sieving is geometrically unrepresentative. The oversized fraction is discarded in the field while the undersize is collected in a calico bag and either transported to a lab for analysis – often over great distances and expense – or analysed on-site or at a field camp using mobile/portable methods.

At early exploration stage, the sampling priority is qualitative (i.e. are minerals of interest present?). Follow-up resource definition with in-fill sampling occurs much later to quantify mineral reserves prior to mining.

Sieving is fit-for-purpose, where a more complete sample comminution (via crushing and/or milling) is impractical and uneconomic. Sieving also offers advantages for the many target minerals are more prevalent in the finer size fractions – acting to concentrate the sample prior to analysing and effectively increasing sensitivity and the ability to detect low level grades.

Hand-sieving for field samples is repetitive and arduous work. Greatly enhanced productivity can be achieved via mechanised shaking, but the apparatus involved are typically too heavy for field deployment.

A new sieve shaker, the BX-S, has been developed for simple and efficient sieving for in-field and on-site applications. Light enough to carry by hand and battery operated, portable sieving devices can achieve higher quality results far quicker than manual sieving. The sealed lid also retains a higher fraction of ultra-fine material and fugitive dust and limits exposure to harmful respirable dust (e.g. silica).

This paper analyses the sieving performance across a range of input sample scenarios, demonstrating superior performance compared to manual sieving with:

* quicker, more complete/consistent recovery,

* easier cleaning, and

* reduced cross-contamination.