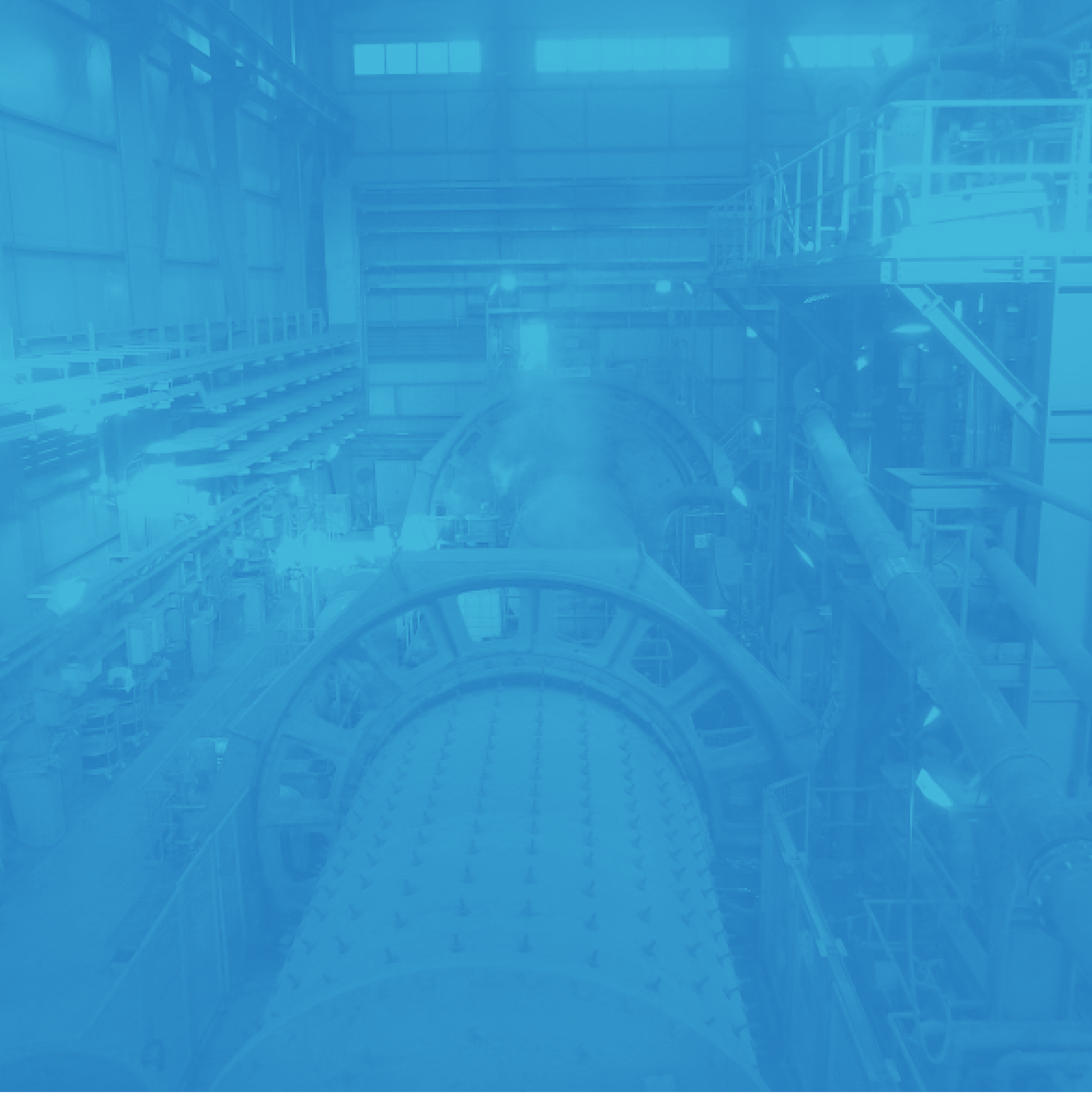

Integrating Mineralogy into Everyday Solutions

Using Process Mineralogy to enhance your operation and save money

Written by Dr Will Goodall & Al Cropp as a publication for Min Assist

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A better understanding of your minerals

Foreword

The aim of this book is to provide a useful guide to integrating mineralogy in to everyday processes and solutions. The intent is not to explain in detail each possible application, but rather to provide an overall introduction to the field of Process Mineralogy, to indicate some of the potential benefits, and to provide a starting point from which to set up and run a mineralogical study.

About MinAssist

MinAssist is a niche consulting group specialising in using smart mineralogical programs to assist the minerals industry to optimise value and reduce technical risks. Founded in 2005, MinAssist has since been involved with projects across a broad spectrum of commodities and ranging in size between 200ktpa to 30Mtpa.

MinAssist provides specialist services to the mining industry in facilitation for the characterisation of complex ores, concentrating on precious metals. MinAssist are at the forefront in using cutting edge technology, coupled with traditional techniques to help you gain a comprehensive understanding of your deposit's mineralogy and how it can affect the metallurgical response of the ore.

MinAssist brings value to its clients by unifying Process Mineralogy and metallurgy.

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Introduction to Process Mineralogy

What is Process Mineralogy?

Process Mineralogy can be considered as the practical application of mineralogical knowledge to predict and optimise how an ore can best be mined and processed. It bridges mineral processing and traditional mineralogy, and is a specialisation within the field of applied mineralogy. Process Mineralogy is being increasingly applied in areas such as geometallurgy, ore characterisation, process design, and in studies from pre-feasibility through to optimisation of an existing operation. The rapid growth of reliance on Process Mineralogy can be attributed to a number of things, primarily: the shift towards increasingly complex and difficult ore bodies; the changing economic drivers leading to greater efficiency and cost savings; and the accessibility to advanced mineralogical technologies and information.

The aim of Process Mineralogy is to identify, diagnose and predict processing characteristics of an ore that are mineralogically controlled or influenced, and to understand either the benefits of these that can be harnessed, or the limitations that need to be catered for. The mineralogy and, most critically the texture, of an ore exert the strongest influence on how the ore can be optimally processed.

Process Mineralogy is typically applied in a range of areas, including:

1) Predicting behavior when the material is still ‘rock’ either before the ore is mined or before it reaches the plant (for example in geometallurgy),

2) Monitoring behavior when the material becomes a ‘plant product’ during or after processing (for example in process/plant optimisation), and

3) Testing behavior during metallurgical test work to save time and money by helping to guide testing and interpret results.

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1. Geometallurgy

Process Mineralogy is closely linked to geometallurgy as it forms one of the largest components of the data and knowledge that is fed in to a geometallurgical predictive block model. Process Mineralogy techniques are aimed at characterising the composition of the ore and predicting how the material can be optimally processed before breakage and liberation occurs. Subsequently linking that knowledge with the reality of how the material actually processes in order to refine the model and prediction.

Rock and mineral properties that can be characterised through Process Mineralogy include; gangue and target mineralogy, grain and particle size and shape (for example indicating target grind size), deleterious minerals (for example slimes, refractory minerals, short and long term acid consumers, those that will change flotation chemistry), deleterious elements (P, Mg, As), mineral associations, and for starting to make predictions on recoverable vs non-recoverable material and generate theoretical grade recovery curves. Valuable insight can be obtained early on about influential factors such as the degree of alteration (oxidation, grain size reduction) and the occurrence of the target and associated minerals (massive, finely disseminated , rims) to aid planning, flowsheet design and plant optimisation.

2. Plant Optimisation

Process Mineralogy is used to examine composite samples collected from critical points within the processing circuit in order to understand the efficiency of each circuit, and identify potential improvements. The knowledge gained about how each ore type processes, and the mineralogical controls, can also then be fed back in to the geometallurgical block model. This allows not only for optimisation of the operation for that ore type at that time, but for prediction of how other ores with similar or different properties may process.

Samples are typically split in to a number of size fractions to improve statistical representivity and data accuracy, from which data on each population can be gathered using a range of techniques. Typical applications include targeting recovery improvements or lowering energy costs through:

- minimising over- or under- grinding,
- optimising flotation chemistry, or;
- catering for high-acid consumers in the leach pad.

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As an example, an operation might chose to run a one-off 'snap-shot' study to examine, say, the grinding circuit. A comprehensive mineralogical understanding of the grinding circuit will highlight the efficiency of grinding which can account for over 40% of the power consumption in some processing operations. Overgrinding the ore means that time and money is being spent unnecessarily reducing the particle size of already liberated minerals, identifying and rectifying this will lead to immediate cost savings. Equally, under-grinding the ore may mean that target minerals remain locked and associated with other material. They may therefore be difficult to recover, or if they are recovered then the concentrate may be unacceptably be diluted, lowering grade and potentially introducing deleterious or penalty phases. Understanding these will allow a recovery / cost model to be developed and a balance between these found..

To continue with this example, whilst there are benefits to running this study as a one-off, implementing a continuous program on a daily, weekly or monthly basis will lead to a more complete understanding on ore variability and grinding operational efficiency, allowing on-going circuit optimisation and geometallurgical block model refinement.

The same concept can of course be applied to other critical circuits in the operation. A heap leach pad could be monitored at different depths and points over time to understand and predict optimal time on the heap, acid consumption and mineral alterations (among other things). The rougher concentrate and tail of a flotation circuit might be monitored to understand what is being lost and why, and determine whether these can be reduced, or are necessary losses.

Establishing a regular and on-going Process Mineralogy program will lead to significant long-term benefits through deeper understanding of an ore and an operation over time.

3. Guiding Metallurgical Testwork

Process Mineralogy studies can also be used to guide, interpret and optimise metallurgical test work. An understanding of the ore and it's mineralogical characteristics will aid the initial scoping of the program, focus testwork and aid data interpretation, thereby reducing uncertainties and supporting decision making.

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What can an understanding of mineralogy bring you?

The knowledge gained from undertaking a well-defined and focused Process Mineralogy study on an operation can have a significant impact on:

- reducing operational costs,
- optimising recovery,
- improving orebody knowledge, and
- lowering technical and operational risk.

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Setting up a SMART Mineralogy Testwork Program

Where to start?

Think of Process Mineralogy as ‘mineralogy for processing engineers’. This is distinctly different from traditional mineralogy. You want a concise report that highlights the key mineralogical controls on a process, not a full mineralogical investigation on every mineral (relavent or not) in your sample(s). So, find a process mineralogist and discuss your operation and challenges. They will help identify what is required to answer your questions.

A good process mineralogist would much rather start a discussion with ‘how fine do I need to grind?’, ‘flotation recovery has dropped’ or ‘what is going to impact my long-term acid consumption?’, than ‘can you do some mineralogy on this?’.

The key is to understand the question you are asking. What is the problem you are trying to solve? This will define the entire mineralogical program from sampling strategy to the test work program, resulting in a concise and focused final report – saving time, money and giving a much more valuable end result.

Once a program has been defined, review this carefully before commencing work. Mineralogy testwork program’s, like any other testwork program, require careful planning and a consistent goal to ensure that the questions asked initially are those answered. Upon receipt of the report, discuss the results and findings with your process mineralogist.

There may well be more questions raised than were originally considered – these might be easily answered, or may result in further work to build on the knowledge and understanding.

What's Needed to get the Most Value?

The infrographic below sets out the core stages that MinAssist considers characteristic of a successful Process Mineralogy program.

1. Understand Process Mineralogy

Process Mineralogy is "Mineralogy for Metallurgists"

2. Discover

Work with your Process Mineralogist to discuss your challenges.

3. Focus & Prioritise

Understand and articiulate the objectives and outcomes desired.

4. Scope

Develop a specifc testwork program that will deliver based on #3

5. Knowledge

The testwork program should result in a simple, concise report and detailed discussion with the Process Mineralogist that delivers results.

SMART Objectives and Deliverables

A method used very effectively at MinAssist has been the implementation of SMART mineralogical programs. The SMART methodology is a well-known and useful tool in goal setting, but is equally applicable when evaluating the effectiveness of testwork programs. Following a program such as this will help even the uninitiated to define the specifics of the program and undertake the relevant interpretation to maximise the value of results. This tool should ensure that any use of mineralogy is worthwhile.

S

Specific

Understand the QUESTION you are asking of mineralogy

Define clear goals and deliverables for the program.

Separate deliverables by individual ore type or process stream.

Be clear how the mineralogy program fits with other testwork or process data.

Clearly define the samples to be examined, how they will be generated and what preparation will be required.

M

Measurable

Define metrics to define the success of the mineralogy program. Eg. Level of agreement between mineralogical and chemical assays; provision of specific reporting items etc.

What information are you specifically seeking?

A

Attainable

Ensure that metrics and deliverables are realistic and attainable for the level of testwork undertaken. There is no point aiming for a 5% increase in metal recovery after looking at just one stream by mineralogical analysis

R

Relevant

Define deliverables that are relevant for the project being undertaken and measure reporting against this. There is no point reporting liberation of the value mineral in a SAG mill feed when looking to improve flotation recovery.

Too much information can reduce the effectiveness of the report and mean that important findings are missed.

T

Timely

The program should be kept within a reasonable timeframe. For larger programs a series of stage gates should be introduced with measureable deliverables to keep the project flowing.

Measuring the structure of a mineralogy testwork program against the SMART guidelines allows for an objective approach to decision making. Mineralogical studies will provide a vast amount of data, especially when automated analysis techniques are employed; however this can be a double-edged sword. Not enough information can lead to misinterpretation and leave a high level of risk in the decisions taken from the results, whilst too much can simply be overwhelming and mask the pertinent points. A well-defined and focussed project will enable you and the mineralogist to find the right balance here and ensure success.

Points for Consideration

If you are unfamiliar with the specifics of what a mineralogy program should look like, there are a few points that should be considered whenever embarking on one. These can be considered as a short workflow checklist:

Choosing a service provider

Naturally, the service provider must be in a position to be able to supply you with not only the range and type of analysis that you require, but also offer you the level of technical support you need in scoping the project, sampling, reporting and interpretation. In some cases, you may simply be after the test results, however in others a much higher level of support might be required depending on the skills accessible to you and the time available for you to use them.

Sampling, sampling, sampling

Once the project aim has been clearly defined, the primary consideration at the start of the study - and one that cannot be overemphasised - is the importance of gaining a representative sample. Without this, then everything else is at best a waste of time and money, and could lead to mis-leading and incorrect data and therefore decisions. Again, the reference point for defining the sampling strategy is the project aim – what question are you asking?

Make sure the sample collected is representative of the target material(s), considering both the grade and texture. By way of example:

1. Are you looking to study the bulk mineralogy making up 95% of the sample, or to look at say copper deportment at a grade of 0.5% (or both)? If you collect and analyse a sample for a bulk mineralogy study, do not then expect to also gain a representative and valid insight in to copper deportment.

2. Are the target minerals finely disseminated or in nuggets in the sample (or do you not know)? If the texture of the target minerals is nuggetty (or unknown) then it is likely that more material will be required to ensure representivity (too little material will result in poor statistics).

It is also important to discuss this with the service provider as it will control their sub-sampling, sample preparation / presentation, and analytical processes.

Data analysis and interpretation

What level do you require here? Be realistic about both the skills you have available to you (your own or your colleagues), and the amount of time you have to apply them to look at the data and interpret results. It may well be fine to just request raw data or a basic report from your service provider to save a little time and/or money, however this may prove to be a false economy if you don't have the time and/or experience to deal with that. If you require the additional support to come from the service provider, it is best to understand that at the outset of the project and to cater for it.

Whatever form the results or report come in, they should align directly with the well-defined objectives set at the start of the project.

Common Pitfalls

"We must do mineralogy"

All too often this is the situation because "everyone knows you should do some mineralogy" – but don't necessarily understand how, or the potential benefits. Understand where mineralogy fits. Mineralogy, just like assays or batch flotation tests, is a tool we use as an input for solving problems, not the solution itself. It provides an understanding that can be used for informed decision making.

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“Mineralogy is not useful” or “Mineralogy is too confusing”

Without an understanding of what the end goal is, or the question(s) being asked, mineralogy can easily be a waste of time and money. A poorly defined mineralogical test program will result in a large, frustrating, confusing and disappointing mineralogical report that whilst probably being entirely correct, lacks the focus to give relevant information succinctly. It can however become not only useful but also very quickly essential - with the right implementation. A well-managed Process Mineralogy study will be concise and focused on the issues you face.

“Mineralogy is expensive”

This is not always true, and the key is to understand the potential benefits and return on investment. A well-constructed program can quickly highlight target areas for improvement, make metallurgical testwork more efficient, and add genuine value to the greater project, leading to both tangible and intangible financial benefits.

“Mineralogy takes too long”

Historically this may well have been the case with a limited number of skilled people and appropriate tools, and is still sometimes true – but it need not necessarily be so. Ask service providers about their turnaround times and discuss your timeframe and drivers. Be clear about your objectives – very often mineralogical studies can take time because the project is unfocused and therefore ‘looking at everything’ – when it may very well be that a quick study can answer your question.

A well-defined test program will speed up analytical and reporting time as unnecessary data may not need to be collected and analysed.

The advances in mineralogical techniques and technologies particularly over the last 10 years means that analysis and reporting can take place much more quickly. Combined with the skill of an experienced process mineralogist, the time-limiting factor now is often workload. Shop around to find a group that can meet your requirements – but be realistic in your requests!

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Mineralogical Influences on Processing and Recovery

The mineralogy and texture of an ore exert a primary control on the choice and efficiency of processing techniques. The following provide some examples of the mineralogical influences on key circuits.

Grinding

Identifying the target grind size and optimising liberation is vital to any process of separation, be it gravity, flotation, leaching or any other. Effective comminution will not only optimise recovery, but will streamline what is typically the most expensive stage in the process, with considerable potential cost savings on offer.

Bradshaw et al. 2011 present a case study from the Kennecott Utah Copper Concentrator where the cause of low recovery of an ore type is identified. Two ores with similar copper head grades are studied, with one achieving target recovery (~80%), and the second recovering poorly. They identify several causes, all mineralogically controlled, with the copper-bearing minerals reporting to a finer size fraction than originally thought, resulting in them remaining locked in composite particles and being a cited as a primary factor for the low recovery.

Flotation

The importance of mineralogy to flotation is neatly encapsulated in this quote from Butcher 2010, from the proceedings of the Centenary of Flotation Symposium 2005 by Xstrata Technology:

> "*Flotation isn't about flotation cells. It is about minerals. Liberating the right miner als in the right place with the minimum of grinding power. Preparing the surfaces for maximum selectivity for valuable minerals against gangue. Minimising entrainment. Responding to the needs of different size fractions. Doing all this at minimum cost, using the least new equipment possible. Understanding the economics of the oper ation. And making the whole circuit work together, simple, responsive and operable*."

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Leaching

Baum (1999) provides an excellent summary of the importance of mineralogy to leaching and leach testwork, with particular reference to copper extraction. He points to copper and gangue mineralogy as being the most critical factors in hydrometallurgical processing, with minor changes in mineralogy severely impacting the entire process from comminution, agglomeration, acid consumption, copper extraction and PLS impurity loading. He also highlights the control texture (size, liberation, locking) can exert on the extraction rates. These, along with a host of other mineralogical and alteration features (such as fast vs slow acid consuming non-carbonate minerals) are given as examples of how critical process mineralogical characterisation is to a leach operation.

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Process Mineralogy – Analytical Techniques

There are a wide range of tools and analytical techniques available in the Process Mineralogy toolbox. This guide aims to provide a simple introduction to the most widely used ones. It is perhaps easiest to think of each as a piece a jigsaw puzzle – rarely does one technique provide the whole picture, but each ones does fill in a different part. It is therefore extremely common to use more than one technique in a study to ensure the right information is obtained in the most efficient manner – the trick is to know which ones and how to use them.

Analytical Techniques Summary

	Advantages	Disadvantages
Optical Microscopy	Cheap (can be) Accessible Comprehensive Good for primary phases Modal mineralogy Texture 2D Non-destructive (sample can be reused)	Requires skilled optical microscopist / mineralogist Poor for trace phases Poor for compositional variation Subjective Results my vary between mineralogists
XRD	Bulk technique Good for crystal structure Cheap (can be) Accessible Good for clays, Fe-oxides, polymorphs	No texture (size, shape, association, liberation) Destructive technique

Continued next page...

Analytical Techniques Summary Continued

	Advantages	Disadvantages
SEM	Modal mineralogy Elemental composition Crystal structure Cathodoluminescence Higher magnification Non-destructive	Requires skilled mineralogist and SEM operator Relatively expensive equipment Not readily accessible – needs specialist laboratory Manual
Automated Mineralogy	Modal mineralogy of major, minor and trace phases Textural quantification (size, shape, liberation, free surface area) Automated, fast, repeatable Mineralogist focused on report and interpretation, not data collection Non-destructive	No differentiation of polymorphs Relatively expensive equipment Not readily accessible – needs specialist laboratory
Micro-Probe	Low-detection limits (ppm to ppb) High level of accuracy Operated through research intitutions with associated expertise Capable of determining trace elements in mineral grains	Expensive Manual operation required and slow to operate. Spatial resolution is poor Equipment very expensive Not readily accessible – needs a

Detailed analysis below...

Optical Microscopy

Optical microscopy perhaps represents one of the most widely used techniques around the world, allowing the user to examine the mineralogy and texture of samples by eye, manually. Modal mineralogy percentages can be gathered, certainly for the main phases, through the use of point counting: stepping across the surface of a sample on a predefined grid, and making note of the mineral under the cross-hairs at each point. Textural features can also be noted semi-quantitatively (liberation, association, sectional sizes). Optical microscopy is good for describing the mineralogy and textural features of the main phases, but can be slow or limited when examining trace phases due to the scarcity of occurance. Compositional variations within minerals can also be difficult to identify (e.g. pure vs impure sphalerite).

Reflected light is typically used for most ore minerals (sulphides, metals, oxides) as they are generally opaque, whilst transmitted light is more often used to identify gangue minerals (silicates, carbonates) as they are generally transparent to translucent. Light polarisers can also assist with identification.

Sample presentation is typically in the form of polished blocks for reflected light (either slices of rock or particles mounted in a resin), or as polished thin sections (most commonly 30 µm thick) for transmitted light examination. Generally, optical microscopy examines the 2D sections of cut and polished minerals, although loose grains can also be usefully examined depending on the purpose of the study.

Optical microscopy can be one of the least expensive techniques to use, and can provide either a ‘quick look’ at a sample, or a fully detailed characterisation as required. Naturally however the whole process relies entirely on the skill and experience of the microscopist, and could be considered ‘subjective’ – particularly if several microscopists are involved – making it potentially difficult to build a mineralogical database over time / over many samples, that is both statistically valid and gives consistent and comparable results. Unfortunately, highly skilled and experienced optical microscopists are also a decreasing and greying workforce – and those who are working are often in high demand, which impacts turnaround time.

X-Ray Diffraction

X-ray diffraction (or XRD) is a bulk analytical technique that is used to identify the minerals and their relative abundances within a sample. The sample is normally pulverised and the different x-ray diffraction patterns made by the crystal structure of each phase are used to the identification of the minerals present.

It is a very useful technique for mineral grade control, or for distinguishing phases within certain mineral groups such as clays or minerals with similar elemental compositions such as Fe-oxides. It can also be used to identify polymorphs; phases with the same composition but different crystal structure such as rutile and anatase.

XRD is widely used, and can be a relatively quick and cost effective method of analysis for bulk mineralogy, or tracking certain minerals. XRD does not provide any textural (size, shape, liberation, association) information.

Scanning Electron Microscope

Scanning Electron Microscopes (SEM) have been widely used to study mineral samples for the last 40 years or so. An electron beam is used, that can be either focused on a single point for specific analysis, or used to 'scan' the surface to examine an overall area under magnification (typically between 50x to in excess of 1,000,000x magnification). They continue to build on the information provided through an optical microscope, with the addition of features such as:

- Electron optics for higher magnification
- Backscattered electon (BSE) signal, which gives a grey-scale image of an area, with brighter points indicating denser material (e.g. metal sulphides) and darker areas indicating less dense material (e.g. silicates).
- Secondary electron (SE) signal, which gives a grey-scale image of the topography of an area
- Energy dispersive (EDX) or wavelength dispersive (WDS) x-ray detectors for elemental composition of points
- Electron backscattered diffraction (EBSD), which will provide information on the crystallographic orientation of an area

A skilled SEM operator and microscopist can provide a great deal of additional information on top of that provided using an optical microscope, using similar (or the same) samples. Again however the challenge lies in ready access to these skills, as well as the relatively more expensive SEM equipment (compares to optical microscopes). Sample analysis is a manual process, and can be time consuming.

Automated Mineralogy

Automated mineralogy tools are perhaps the most powerful pieces of equipment in the process mineralogist's arsenal, and have revolutionised the field.

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Automated mineralogy systems are based on SEM's, and were first developed in the early 1970's; however only in recent years (say this century) have they become more widely available. They provided a significant step forward in mineral analytical technology being specifically designed for the mining industry and allowing for the first time an automated method for both identifying minerals and quantifying their textures. These systems are now widely used to routinely characterise mineral samples from operations and commodities all over the world, and for applications ranging from exploration, through geometallurgy, to recovery optimisation and tailings management. These are now operated by internal laboratories within mining companies, external analytical service providers, and research organisations globally.

The SEM is fitted with EDX (X-Ray) detectors, and integrated with specialist automated mineralogy software and a 'mineral library'. The software uses the SEM to scan the surface of the sample, collecting the elemental composition of the minerals present. This information is then used (often in conjunction with the backscattered value) to identify the mineral present. The speed of analysis is such that many hundreds of points can be positively identified every second, providing a very rapid method for gathering modal mineralogy percentage data.

In addition, automated mineralogy systems are designed to generate false-colour images of the minerals in the sample, which can then be interrogated using image analysis to quantify various textural features such as sizes, shape, associations, degree of liberation and free surface area.

A wide range of measurement modes allow the instruments to be optimised to the specific purpose of the study, ensuring that statistically valid data is collected on the minerals of interest in the shortest analytical time possible. Examples of this include:

- Bulk mineralogy (modal and texture) of the main phases present
- Specific searches for certain selected minerals (e.g. metal sulphide deportment studies)
- Trace searches for trace phases (Pt, Au) in very low grade

The speed allows quantitative statistics to be gathered about the mineralogy of the sample, whilst the automation reduces the manual workload of the skilled operator allowing them to 'oversee' the analysis whilst focusing on reporting and interpretation (rather than mainly the data collection).

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The two original commercially available automated mineralogy techniques were both developed in Australia (QEM*SEM and MLA) to specifically to cater for the growing need in the mining industry for rapid and repeatable mineralogical and textural quantification of minerals – and in particular their degree of liberation. There are a number of techniques now available:

- QEMSCAN orginally developed by CSIRO in the early 1980's (now by FEI)
- MLA developed by University of Queensland and JKMRC in 1997 (now by FEI)
- TIMA developed by Tescan in 2012
- INCA Minerals developed by Oxford Instruments in 2011
- Spatially Resolved X-Ray Analysis of Minerals developed by Bruker

Microprobe Systems

High-resolution microprobe systems provide an additional level of detail to the more routine mineralogical analysis systems. These systems provide much higher levels of chemical resolution, translating to lower detection limits for most elements and the capability to quantify trace elements hosted in the matrix of mineral grains. In comparison to scanning electron microscope based systems they are more manual to operate and expensive, generally only being available through dedicated research institutions.

A number of examples of microprobe systems include, Electron Probe Micro-Analysis (EPMA); Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS); Proton Induced X-Ray Emission (PIXE) and Mossbauer Spectroscopy.

These systems range in resolution, with EPMA allowing detection of elements in the ppm range but TOF-SIMS and micro-PIXE providing resolutions in the ppb range. Conversely, the energy required to achieve lower detection limits results in broader beams and the spatial resolution of microprobe systems is generally in the range of tens of microns.

Typically, EPMA would be utilised more routinely to define trace elemental components of minerals. This is especially useful in determination of where an identified mineral sits within a solid-solution series with other minerals. For economic minerals EPMA can be utilised to define where the value metal is association outside of the major host mineral. A good example of this is for Ni sulphide ore bodies, where pyrrhotite may contain Ni at trace levels and become a significant host.

The more powerful microprobe systems, TOF-SIMS and micro-PIXE, have been used to great effect in identification of sub-micron gold in refractory gold deposits.

Conclusions

There can be no doubt as to the value of Process Mineralogy in today's modern mining and mineral processing operations. A dedicated conference is run to cater for the growing field of specialists in Process Mineralogy (Minerals Engineering International's Process Mineralogy Conference) and applied mineralogy (International Congress on Applied Mineralogy – ICAM), and in addition, dedicated Process Mineralogy streams are run at many other conferences such as the AusIMM Geometallurgy Conference, and the International Mineral Processing Congress (IMPC).

With increasingly complex ore bodies and growing financial pressures, few sites can now afford to ignore the potential benefits that can be gained through improved mineralogical understanding.

In addition, MinAssist is a leader in mineralogy and metallurgy services. We would be happy to answer any questions you may have or discuss potential next steps if you are considering a mineralogy program. Please contact us using the details below and we encourage you to follow our blog and subscribe to our newsletter on the MinAssist website.

Website and Newsletter

www.minassist.com.au

Process Mineralogy Today Blog

www.minassist.com.au/blog

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