

MINERALS SERVICES

# **SCHEDULE OF SERVICES** 2017

INDONESIA



# PROVIDING SERVICES ACROSS THE RESOURCES SUPPLY CHAIN

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Intertek is a leading Total Quality Assurance provider to industries worldwide. Our network of more than 1,000 laboratories and offices and over 42,000 people in more than 100 countries, delivers innovative and bespoke Assurance, Testing, Inspection and Certification solutions for our customers' operations and supply chains. Intertek supports companies' success in the global marketplace, by helping customers to meet end users' expectations for safety, sustainability, performance, integrity and desirability in virtually any market worldwide.

Our network of mineral laboratories offer world class geochemical assay and testing services including sample preparation, fire assay and precious metal analysis, exploration geochemistry, environmental testing, mine-site laboratories, coal testing and inspection, consulting minerals inspection, robotics and automated laboratory systems.



**QUALITY ANALYSIS,  
EFFICIENT, INDEPENDENT,  
& COST-EFFECTIVE SERVICE.**  
**GLOBAL SCOPE,  
LOCAL PRESENCE.**

100 Countries.  
1000 Laboratories.  
42,000 Employees.

## ROBOTICS AND AUTOMATED MINERALS LABORATORY SYSTEMS

Intertek is the largest global commercial operator of automated and robotic mine site laboratories.

Intertek automated and robotic sample systems are purpose built, ranging from individual cells to fully integrated systems, providing complete end-to-end sampling to analysis solutions.

Using advanced robotic sample handling technology for minerals testing has distinct advantages, including rapid sample throughput, unparalleled consistency, exclusion of human error, a comprehensive audit trail, synchronised process control, reliability and fully programmable comminution parameters. Programmable parameters ensure that ores obtain the requisite treatment consistently.

Robotic systems reduce OH&S exposure to employees, eliminating heavy lifting and isolating personnel from hazardous materials. Thus significantly improving safety.

## ADVANCES IN GEOCHEMICAL ANALYSIS

The challenge of identifying geochemical anomalies related to concealed mineral deposits has driven innovation and development in analytical geochemistry.

Streamlined, ultra-clean digestions coupled with the latest ICP-MS collision cell technology offer improved detection limits commensurate with the crustal abundance of almost all elements, with an emphasis on long-term reproducibility.



**INNOVATION  
THROUGH  
TECHNOLOGY**

## MINE-SITE LABORATORIES

Intertek designs, commissions and operates dedicated mine-site laboratories in remote locations and key mining regions across the globe and supports a range of mineral commodities. Mine-site laboratory services range from sample preparation installations to full service analytical laboratories and automated robotic facilities.

Intertek's minerals laboratories are operated by experienced personnel with support from an extensive global laboratory network. Fast, accurate and independent mineral analyses by Intertek allow mining companies to effectively manage their process control and regulatory reporting requirements.

Outsourcing your mine-site laboratory to Intertek ensures your operation will benefit from world-class expertise and services, which enables your company to focus resources and capital on the core business.

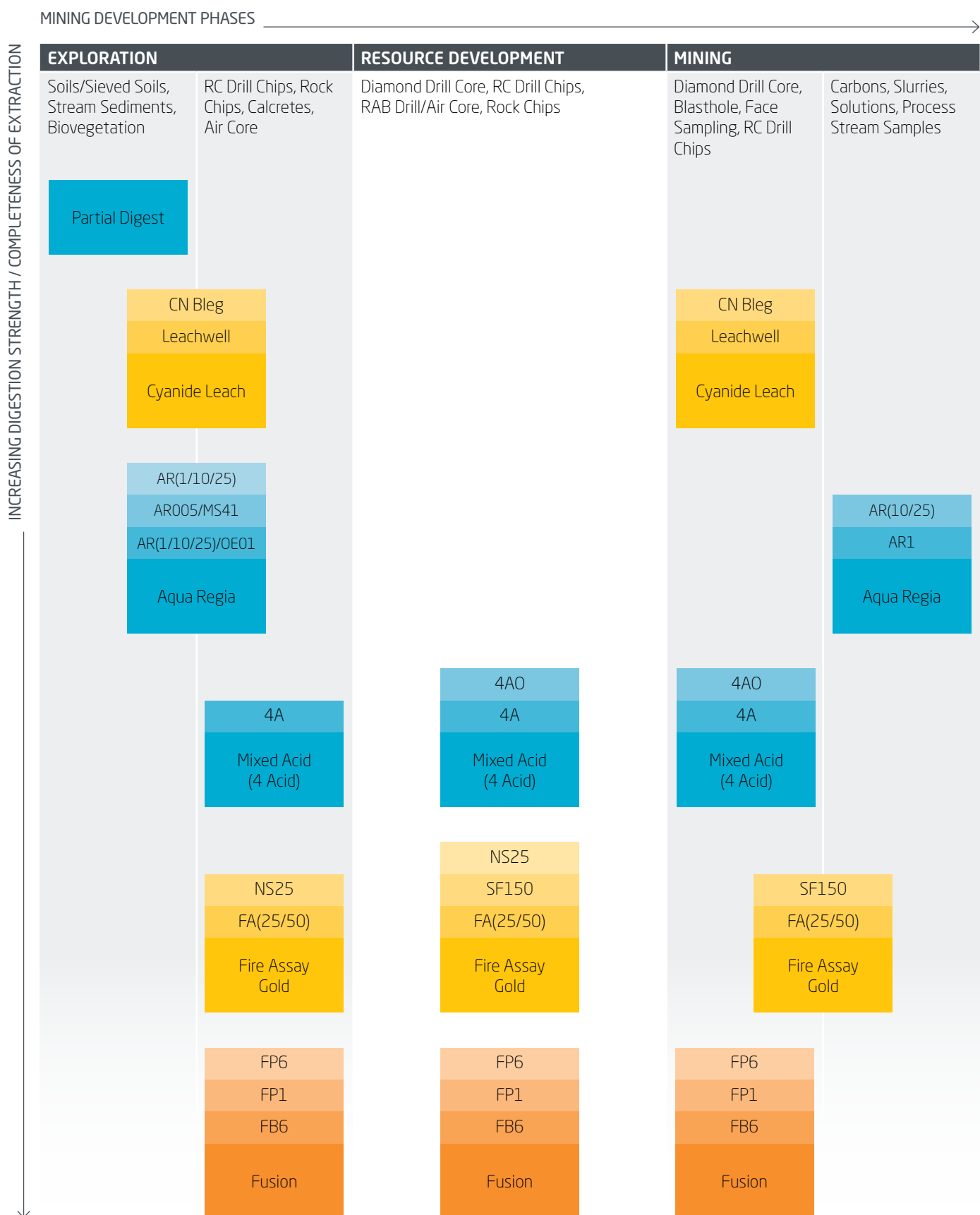
## MINERALOGY

Intertek's leading expertise and state-of-the-art facilities offer a range of mineralogical services. Technical specialists in XRF and XRD support local and global operations, producing quality reliable data with the reassurance of years of experience and a proven track record.

- Research quality lithogeochemical packages
- Applied bulk mineralogy
  - XRD instrument and specialists on site
- Low cost XRF & spectral scanning
- TerraSpec Near-Infrared Spectroscopy
- FTIR Spectroscopy
- Applied Micro Mineralogy QEMSCAN



# APPLICATIONS



The Australian schedule outlines the most commonly used analytical procedures. Not all methods are available at all locations. Please contact your local manager to discuss your specific requirements or for any services not listed.

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# SAMPLE PREPARATION

The production of a homogeneous sub-sample, representative of the material submitted to the laboratory is the primary purpose of sample preparation. Correct preparation is critical to obtaining meaningful analytical results. The selection of the actual sample preparation procedures will depend on the type and size of the sample, the mineralogy as well as the client's analytical and budgetary requirements.

Segregation into high and low grade sample preparation areas and utilisation of techniques such as vacuuming pulveriser vessels and/or quartz washes between samples reduces the potential for contamination. Robotic preparation employing quartz washes is also available at some facilities.

Close and ongoing consultation with your Laboratory Manager or Sales Representative will ensure that optimal sample preparation techniques are employed thus maximising the value added in the analytical process.

## SAMPLE SUBMISSION

Correct submission and receipt of samples is critical in retaining the integrity of the sample chain of custody and facilitating efficient processing of samples. Detailed instructions can be found on Page 27 and submission forms can be downloaded from the Intertek website [www.intertek.com/minerals](http://www.intertek.com/minerals)

Sample submission and freight information emailed prior to despatch will expedite the sample receipt process. Upon receipt, samples are issued with a unique barcode ID through the LIMS. Clients are encouraged to submit pre barcoded samples to enable efficient sample receipt and reconciliation.

## SAMPLE STORAGE

All solid samples (assay pulps, bulk pulps and residues) will be stored without charge for 90 days after completion of analysis. After this time all samples will be stored at a daily rate until the client's written advice regarding return, collection or disposal is received.

DESCRIPTION	CODE
Storage of pulps	ST102
Storage of bulk residues	ST202
Storage of coarse residue	ST203
Labour for handling pulps/residues	ST204
Disposal of pulps / residues	ST205
Packing of samples to be returned	RT201

Samples submitted as liquids will be stored (at ambient temperature) without charge for 90 days after completion of analysis and then discarded unless advised otherwise in writing.

## FREIGHT

Freight expenses incurred will be passed on at cost.

## SAMPLE PREPARATION PACKAGES

To facilitate easy selection of sample preparation procedures, commonly used techniques have been packaged together.

### Partial Preparation Package

DESCRIPTION	CODE
Sort, dry (105°C), crush (95%<5mm), riffle split, pulverise 1.5kg (95%<75µm) up to 2.0kg	SP123
Additional weight	SP124
Sort, dry (105°C), crush (95%<2mm), riffle split, pulverise 1.5 kg (95%<75µm) up to 2.0kg	SP132
Additional weight	SP133

### Total Preparation Package

DESCRIPTION	CODE
Sort, dry (105°C), crush, pulverise all (95%<75µm) up to 1.5kg	SP111
Additional weight	SP113

### Soil and Stream Sediment

DESCRIPTION	CODE
Sort, dry (105°C), pulverise all (95%<75µm) up to 1.5kg	SP101
Additional weight	SP103

## SAMPLE PREPARATION PROCEDURES

### Drying

Sample drying procedures will vary due to the sample type and mass, moisture content and analysis required.

DESCRIPTION	CODE
Sort and dry samples at 105°C	SD02
Sort and dry samples at 60°C	SD03

### Crushing

Samples with a volume or dimensions exceeding that which the pulverising vessels can accommodate may require crushing and/or splitting prior to pulverising. Crushing may also be required to achieve an optimum particle size to split to a representative sub sample for further particle size reduction.

DESCRIPTION	CODE
Crush to ~5mm	CR07
Crush to ~2mm	CR02

Quartz wash packages are available on request

### Splitting

Splitting of samples may be done to achieve a more cost effective option in reducing the volume of sample for further particle size reduction steps.

Two types of splitters are used; the riffle splitter sometimes called a Jones Splitter and the Rotary Splitter. It is important to select the correct size splitter for the product being split, correct technique is also important in order that samples are split without introducing bias.

DESCRIPTION	CODE
Riffle splitting – Up to 6kg retain reject	RF02
Rotary or arcual splitting	RS01

## Pulverising

Pulverising is carried out on crushed or fine products to achieve a fine homogeneous powder to enable small sub-samples to be taken for analysis that will be representative of the larger coarse sample. For most sample types at least 95% of material will be pulverised to 75µm or better.

All devices used in the crushing and pulverising of samples can impart trace levels of contaminants. Low chrome steel is often the preferred material of choice for pulverising vessels as the chrome and iron contamination is usually negligible compared with the levels commonly encountered in most geological materials.

DESCRIPTION	CODE
Fine pulverise, 95% < 75µm, up to 1.5kg	PU102
Fine pulverise, 95% < 75µm, additional weight	PU104

## Sieving

Sieving may be performed on unprocessed samples to determine the mass distribution of the various size fractions or alternatively, on crushed or pulverised products to ascertain the effectiveness of the processes.

DESCRIPTION	CODE
Dry sieve specified mesh size 1 fraction	SV101
Dry sieve to specified mesh sizes additional fractions	SV101A
Wet sieve (retain oversize only)	SV102
Wet sieve (recovering undersize & oversize)	SV102A
Quality control check sizing - 75µm	SV203
Quality control check sizing - 2mm	SV208

## Miscellaneous Procedures

DESCRIPTION	CODE
Client specified preparation	CP01
Roasting, pulp only up to 200g	PR01
Reporting weights of samples, wet or dry	WT01
Compositing / Homogenising <= 2kg	CM201
Additional weight	CM202

Other sample preparation processes (preparation of carbons, magnetic or heavy media separation, compositing & homogenising etc) are also available. Please contact the laboratory to discuss your requirements.

# PRECIOUS METALS ANALYSIS

A diverse range of precious metal analytical techniques are available for a wide range of applications ranging from grassroots exploration, where sub ppb sensitivities are required, to accurate resource estimation and grade control.

Lead collection fire assay remains the classic method for gold, platinum and palladium, however, aqua regia digestion, accelerated cyanide leach and BLEG (bulk leach extractable gold) are available for specific purposes. The full suite of platinum group elements can be quantified using nickel sulphide collection fire assay.

## LLEAD COLLECTION FIRE ASSAY

Fire assay flux recipes have been carefully formulated to optimise precious metal recovery in diverse mineralogical matrices. Further flux modification and reduction in charge weight can be used to improve recoveries in difficult sample matrices.

ELEMENT	DESCRIPTION	DETECTION LIMIT	CODE
Au	25g fire assay / AAS	0.01ppm	FA25/AA
Au	50g fire assay / AAS	0.01ppm	FA51/AA
Au	50g fire assay / AAS	0.005ppm	FA50/AA
Au	50g fire assay / GF AAS	1ppb	FA50/GF
Pt, Pd	As additional element		
Au	25g fire assay / Gravimetric	6ppm	FA25/GR200
Au	50g fire assay / Gravimetric	3ppm	FA50/GR200

\*A \$0.30 surcharge will apply for new pots

Concentrates, metallurgical and high grade samples

POA

## SCREEN FIRE ASSAY

Screen fire assays utilise a large sample mass, typically 1kg, and find application where the precious metal compositional and distributional heterogeneity in a pulp is such that a conventional fire assay would be accompanied by an unacceptable sampling error. The pulp sample is screened and the entire coarse fraction is fired assayed to recover the gold and/or PGEs. Duplicate assays are carried out on the more reproducible undersize fraction. The precious metal content is reported as a mass weighted mean along with the individual fractions' results.

ELEMENT	DESCRIPTION	DETECTION LIMIT	CODE
Au	Screen fire assay 106µm / AAS	0.01ppm	SF106/AA
Au	Screen fire assay 75µm / AAS	0.01ppm	SF75/AA
	Additional oversize firing		
Pt, Pd	Available on request		

## NICKEL SULPHIDE COLLECTION FIRE ASSAY

The specialised nickel sulphide collection fire assay method has been designed to quantitatively recover all of the platinum group elements. The precious metals are collected in a nickel sulphide matte which is dissolved leaving the Au and PGEs as a residue. This residue is filtered off, dissolved in aqua regia and read on an ICP-MS for low ppb detection limits.

ELEMENT	DESCRIPTION	DETECTION LIMIT	CODE
Au	25g NiS fire assay / ICP-MS (Package)	2ppb	NS25/MS
Pt, Pd, Rh, Ru, Ir, Os		1ppb	

## AQUA REGIA DIGESTION

Aqua regia is a low level, cost effective option for analysing gold and other elements in oxide, sulphide and carbonate minerals. It is an empirical method with tightly controlled digest conditions to optimise long term reproducibility. Refractory minerals and silicates may remain largely undigested. Pre roasting is required when samples contain appreciable non-carbonate carbon. Aqua regia digestion is a useful exploration tool and gold analysis can be coupled with multi element packages found under the Exploration Geochemistry section.

ELEMENT	DESCRIPTION	DETECTION LIMIT	CODE
Au	25g aqua regia / AAS	0.05ppm	AR25/AAS
Au	50g aqua regia / AAS	0.02ppm	AR50/AAS
	Pre-roasting (ashing) to remove graphitic / other organic material		R/

## CYANIDE LEACHES

Cyanide extractable gold analysis is used in a range of applications from identification of low level anomalies by BLEG in grassroots exploration to accelerated leaches mimicking metallurgical recovery processes.

### BLEG (Bulk Leach Extractable Gold) - Low Level Gold

ELEMENT	DESCRIPTION	DETECTION LIMIT	CODE
Au	<5.0kg leach / AAS	0.1- 25ppb	CN5000/AAS
Au	5.0 – 10.0kg leach / AAS	0.1- 25ppb	CN5000-1/AAS
Ag, Cu	As additional element		/AA

### BLEG (Bulk Cyanide Leach) - Zinc Collection Low Level Gold

ELEMENT	DESCRIPTION	DETECTION LIMIT	CODE
Au	2.0kg leach Zn collection / AAS	0.02ppb	CZ2000/AAS
Au	5.0kg leach Zn collection / AAS	0.01ppb	CZ5000/AAS
Au	>5.0kg leach Zn collection / AAS	0.01ppb	CZ5000-1/AAS
Ag, Cu	As additional element		/AA

### Accelerated Cyanide Leach LeachWELL™

High grade cyanide leaches utilise the LeachWELL™ accelerant to determine the cyanide extractable gold and provide an indication of potential recoveries in metallurgical processes and circuits. Recovery and analysis of the residues provide the option of reporting total gold values and thus determining the refractory gold fraction.

ELEMENT	DESCRIPTION	DETECTION LIMIT	CODE
Au	200g leach / AAS	0.01ppm	LW200/AA
Ag	As an additional element	1ppm	/AA

Tail recovery, entire tail washed, reground and 25g fire assay Au

ELEMENT	DESCRIPTION	DETECTION LIMIT	CODE
Au	200g wash / grind / fire assay / AAS	0.01ppm	TR200/AA

### Cyanide Bottle Roll - Ore Grade

ELEMENT	DESCRIPTION	DETECTION LIMIT	CODE
Au	<1.0kg leach / AAS	0.01ppm	CNB1000/AAS
Ag, Cu	As additional element		/AA

### Other Cyanide Methods

ELEMENT	DESCRIPTION	DETECTION LIMIT	CODE
Au	5g leach / AAS	0.01ppm	CN5/AAS

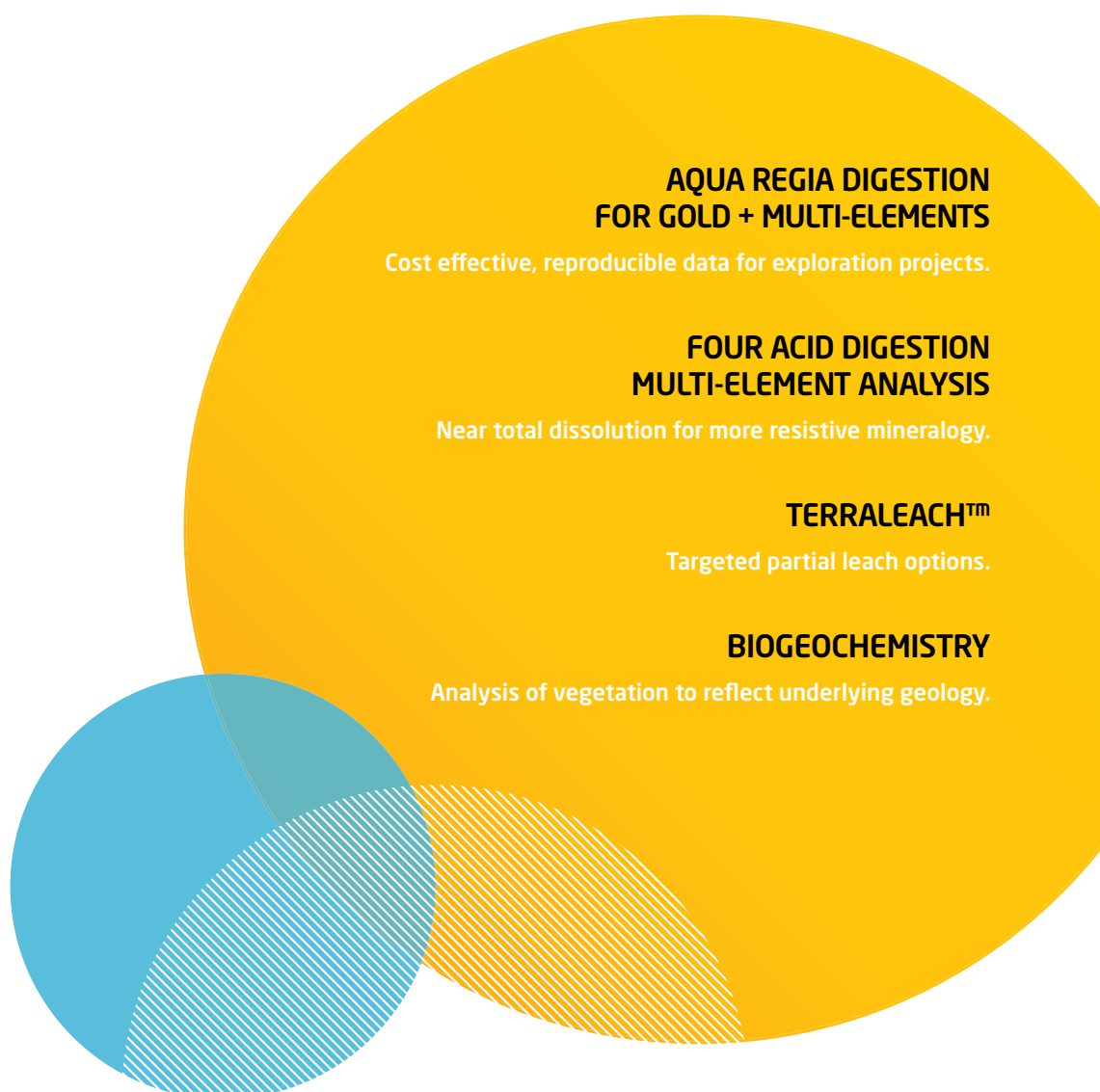
# EXPLORATION GEOCHEMISTRY

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The challenge of identifying geochemical anomalies related to concealed mineral deposits has driven innovation and development in analytical geochemistry.

Advances in instrumentation and methodology offer significant improvements in aligning detection limits with elemental crustal abundances and provide exceptional long term data reproducibility.

A number of exploration methods are offered including partial selective leaches, biogeochemical analyses, aqua regia digestions and near-total four acid digestions. The selection of the most appropriate method is critical to achieving the most successful outcome for your exploration project.



## AQUA REGIA DIGESTION FOR GOLD + MULTI-ELEMENTS

The advent of new analytical instrumentation technologies coupled with streamlined, ultra clean aqua-regia digestion methods provide the best platform for fast, cost effective and consistent trace level analysis for your exploration samples.

The aqua regia digestion is a classical empirical digestion technique with successful global application in geochemical exploration. Most oxide, sulphide and carbonate minerals are digested, however, refractory minerals and most silicates may be only partially decomposed. Recovery levels will vary between the elements and sample matrices with indicative recoveries highlighted on the package tables.

Samples containing graphitic or organic material may require roasting prior to digestion.

## AQUA REGIA DIGESTION PACKAGES

Aqua regia digestion coupled with ICP-OES and ICP-MS offers a cost effective option for gold and multi-element packages.

The 1g options are primarily intended as a multi-element scanning tool. The precious metal results may be indicative only and should be interpreted with caution owing to the deportment of these elements in geological many sample types. Larger sample masses (e.g. 10g or 25g) can offer a more reliable precious metal analysis. Individual elements are available on request.

### 0.5g Aqua Regia ICP-OES Package

ELEMENT	RANGE PPM	ELEMENT	RANGE PPM	ELEMENT	RANGE PPM
Ag	0.1 - 200	K	0.01% - 10%	Se	5 - 2000
Al	0.01% - 10%	La	1 - 2000	Sn	5 - 2000
As	2 - 1%	Li	1 - 1%	Sr	1 - 2000
Ba	1 - 2000	Mg	0.01% - 10%	Ta	5 - 1000
Bi	2 - 2000	Mn	1 - 2%	Te	5 - 2000
Ca	0.01% - 10%	Mo	1 - 1%	Ti	0.01% - 1%
Cd	0.2 - 2000	Na	0.01% - 10%	V	1 - 4000
Co	1 - 1%	Nb	1 - 2000	W	10 - 2000
Cr	1 - 2%	Ni	1 - 1%	Y	1 - 2000
Cu	1 - 1%	Pb	2 - 1%	Zn	1 - 1
Fe	0.01% - 10%	Sb	1 - 2000	Zr	1 - 2000
Ga	2 - 2000	Sc	1 - 2000		

Aqua regia digestion 0.5g / ICP-OES

AR005/OE01

### 1g Aqua Regia Standard ICP-OES & MS Package

ELEMENT	RANGE PPM	ELEMENT	RANGE PPM	ELEMENT	RANGE PPM
Ag	0.05 - 250	In	0.05 - 1000	Sc	1 - 500
Al	20 - 10%	K	20 - 5%	Se	1 - 5000
As	1 - 1%	La	0.01 - 500	Sn	0.5 - 200
B	10 - 1%	Li	0.1 - 1000	Sr	0.2 - 5000
Ba	1 - 2000	Mg	0.01% - 20%	Ta	0.05 - 200
Be	0.5 - 1000	Mn	1 - 1%	Te	0.05 - 1000
Bi	0.05 - 5000	Mo	0.1 - 5000	Th	0.05 - 500
Ca	0.01% - 40%	Na	0.01% - 5%	Ti	5 - 1000
Cd	0.05 - 1000	Nb	0.2 - 200	Tl	0.05 - 1000
Ce	0.01 - 1000	Ni	1 - 2%	U	0.05 - 5000
Co	0.1 - 5000	P	20 - 2%	V	2 - 1000
Cr	1 - 1%	Pb	0.5 - 5000	W	0.1 - 200
Cs	0.02 - 500	Pd**	10ppb - 500pp	Y	0.05 - 200
Cu	1 - 2%	Pt**	5ppb - 500ppb	Zn	1 - 2%
Fe	0.01% - 50%	Rb	0.05 - 1000	Zr	0.5 - 200
Ga	0.1 - 500	Re	0.05 - 500		
Hf	0.05 - 200	S	100 - 5%		
Hg	0.05 - 100	Sb	0.05 - 5000		

Aqua regia digestion 1g / ICP-OES & ICP-MS

AR01/OM210

Note: \*\* Pt, Pd are indicative only on 1g option and must be interpreted with extreme caution

## Aqua Regia Comprehensive ICP-OES & MS Package - Ultra Trace Levels

ELEMENT	RANGE PPM	ELEMENT	RANGE PPM	ELEMENT	RANGE PPM
Ag	0.05 - 250	Ho	0.01 - 200	Sc	0.1 - 500
Al	20 - 10%	In	0.005 - 1000	Se	1 - 5000
As	1 - 1%	K	20 - 5%	Sm	0.01 - 500
B	10 - 1%	La	0.01 - 500	Sn	0.05 - 200
Ba	1 - 2000	Li	0.1 - 1000	Sr	0.02 - 5000
Be	0.05 - 1000	Lu	0.005 - 200	Ta	0.01 - 200
Bi	0.01 - 5000	Mg	0.01% - 20%	Tb	0.005 - 200
Ca	0.01% - 40%	Mn	1 - 1%	Te	0.01 - 1000
Cd	0.01 - 1000	Mo	0.1 - 5000	Th	0.01 - 500
Ce	0.01 - 1000	Na	0.01% - 5%	Ti	5 - 1000
Co	0.1 - 5000	Nb	0.02 - 200	Tl	0.01 - 1000
Cr	1 - 1%	Nd	0.01 - 500	Tm	0.01 - 100
Cs	0.01 - 500	Ni	0.5 - 2%	U	0.01 - 5000
Cu	0.5 - 2%	P	20 - 2%	V	2 - 1000
Dy	0.01 - 200	Pb	0.5 - 5000	W	0.05 - 200
Er	0.01 - 200	Pd**	10ppb - 500ppb	Y	0.02 - 200
Eu	0.01 - 200	Pr	0.005 - 500	Yb	0.01 - 200
Fe	0.01% - 50%	Pt**	5ppb - 500pp	Zn	1 - 2%
Ga	0.05 - 500	Rb	0.02 - 1000	Zr	0.1 - 200
Gd	0.05 - 200	Re	0.001 - 500		
Hf	0.01 - 200	S	50 - 5%		
Hg	0.01 - 100	Sb	0.02 - 5000		

Aqua regia digestion 1g / ICP-OES & ICP-MS

AR01/OM200

Note: \*\* Pt, Pd are indicative only on 1g option and must be interpreted with extreme caution

A selection of individual elements and customised packages are offered to suit your specific needs, or where only a few elements are required. Please consult your local manager for details.

Elements where the concentration exceeds the upper limit will be re-digested by the appropriate analytical method which will incur additional charges.

### LEGEND

Complete recovery for most samples

Near complete recovery for most samples

Not complete recovery

## FOUR ACID DIGESTION MULTI-ELEMENT ANALYSIS

Four acid digestion offers a “near total” dissolution of almost all minerals species, targeting silicates not dissolved in less aggressive aqua regia digests. Carefully staged digestion steps minimise losses due to volatilisation of some elements.

Highly resistant refractory minerals such as zircon, cassiterite, columbite-tantalite, ilmenite, xenotime rutile, barite and wolframite will require a fusion digestion to guarantee complete dissolution.

Packages range from basic ICP-OES only suites through to a comprehensive element list utilising both ICP-OES and ICP-MS for ultra-trace levels. Individual elements are available on request.

### Four Acid ICP-OES Package

ELEMENT	RANGE PPM	ELEMENT	RANGE PPM	ELEMENT	RANGE PPM
Ag	0.5 - 500	Fe	100 - 50%	S	50 - 10%
Al	50 - 15%	K	20 - 10%	Sb	5 - 1%
As	10 - 2000	La	20 - 5000	Sc	1 - 5000
Ba	2 - 5000	Li	1 - 2000	Sn	5 - 2000
Bi	5 - 1%	Mg	20 - 40%	Sr	1 - 1%
Ca	50 - 40%	Mn	1 - 1%	Te	5 - 2000
Cd	0.5 - 2000	Mo	2 - 1%	Ti	5 - 1%
Ce	20 - 1%	Na	20 - 10%	Tl	5 - 2000
Co	1 - 1%	Ni	1 - 1%	V	1 - 5000
Cr	5 - 1%	P	50 - 5%	W	5 - 2000
Cu	1 - 1%	Pb	5 - 1%	Zn	1 - 1%
Acid digestion				4A/OE01	

### Four Acid Standard ICP-OES & MS Package

ELEMENT	RANGE PPM	ELEMENT	RANGE PPM	ELEMENT	RANGE PPM
Ag	0.1 - 500	In	0.05 - 2000	Se	2 - 1%
Al	50 - 15%	K	20 - 10%	Sn	0.1 - 2000
As	2 - 2000	Li	0.1 - 2000	Sr	0.5 - 1%
Ba	1 - 5000	Mg	20 - 40%	Ta	0.05 - 2000
Be	0.5 - 2000	Mn	1 - 1%	Te	0.1 - 2000
Bi	0.05 - 1%	Mo	0.1 - 1%	Th	0.05 - 5000
Ca	50 - 40%	Na	20 - 10%	Ti	5 - 1%
Cd	0.05 - 2000	Nb	0.1 - 2000	Tl	0.02 - 2000
Co	0.1 - 1%	Ni	1 - 1%	U	0.05 - 1%
Cr	5 - 1%	P	50 - 5%	V	1 - 5000
Cs	0.1 - 2000	Pb	1 - 1%	W	0.1 - 2000
Cu	1 - 1%	Rb	0.1 - 2000	Y	0.1 - 2000
Fe	100 - 50%	Re	0.05 - 2000	Zn	1 - 1%
Ga	0.1 - 2000	S	50 - 10%	Zr	0.5 - 2000
Ge	0.1 - 2000	Sb	0.1 - 1%		
Hf	0.1 - 2000	Sc	1 - 5000		
				4A/OM10	

A selection of individual elements and customised packages are offered to suit your specific needs, or where only a few elements are required.

Elements where the concentration exceeds the upper limit will be re-digested by the appropriate analytical method which will incur additional charges.

## TWO ACID DIGESTION FOR MULTI-ELEMENTS

This digest features a high temperature perchloric acid oxidative attack with a hydrochloric acid final leach that is suitable for the analysis of many base metal oxides and sulphides, however silicates and refractory minerals may only be partially attacked. Quantification is offered by an AAS finish.

This digest provides a useful scanning tool. Upper limits are relatively low for some elements, after which re-analysis by a more appropriate method is required.

### Two Acid AAS Individual Elements

ELEMENT	RANGE PPM	ELEMENT	RANGE PPM	ELEMENT	RANGE PPM
Ag	1 - 100	Cr	10 - 1%	Ni	4 - 1%
As	50 - 1%	Cu	2 - 1%	Pb	4 - 4000
Cd	4 - 1%	Fe	0.01% - 8%	V	10 - 1%
Co	4 - 1%	Mn	5 - 1%	Zn	1 - 1%

DESCRIPTION		CODE
2 acid digestion	/ AAS first element C <sub>2</sub> H <sub>2</sub>	2A/AA201
	/ per additional element C <sub>2</sub> H <sub>2</sub>	
2 acid digestion	/ AAS first element N <sub>2</sub> O	2A/AA202
	/ per additional element N <sub>2</sub> O	

## PRESSED POWDER XRF FOR TRACE ELEMENTS

Pressed powder XRF is a useful technique for the rapid analysis of trace to minor quantities of single elements using quick matrix correction. The pulverised sample is mixed with a binder and pressed into a briquette which removes the need for digestion and facilitates the analysis of elements present in refractory minerals. Control of grinding parameters reduces errors due to particle size and mineralogical effects. The pressed powder method is suitable for light matrices. Samples may be diluted with silica to expand the range and reduce matrix effects.

ELEMENT	RANGE PPM	ELEMENT	RANGE PPM	ELEMENT	RANGE PPM
As	1 - 5000	Sb	3 - 5000	Tl	4 - 5000
Ba	10 - 5000	Se	4 - 5000	W	5 - 5000
Bi	10 - 5000	Sn	3 - 5000	Zr	5 - 5000
Mo	1 - 5000	Ta	4 - 5000		
Pb	10 - 5000	Te	5 - 5000		

DESCRIPTION		CODE
Pressed powder	/ XRF including first element	PP/XRF201
	/ per additional element	
Over range elements, dilution including first element		PP/XRF202
	/ per additional element	

LEGEND		
Complete recovery for most samples	Near complete recovery for most samples	Not complete recovery

# ORES & COMMODITIES

A diverse suite of procedures provide optimum precision and accuracy of the target element typically required in advanced exploration and resource evaluation. Techniques include multi-acid and fusion digests, useful for characterisation of geological samples where total dissolution of the sample is required, coupled with ICP-OES, ICP-MS and XRF instrumentation.

Trade commercial grade sample analysis where results are used for umpire or commercial settlement are available on request, see the Minerals Trade Services section on page 25.

## ORES AND HIGH GRADE MATERIALS

### Acid Digestion

High grade sulphide ores are readily quantified using a 4 acid digest formulated to retain low-solubility elements such as Pb and Ag in solution at higher concentrations. This is a near total dissolution however elements incorporated in high refractory minerals may not be completely digested.

#### Four Acid Ore Grade AAS Individual Elements

ELEMENT	RANGE PPM	ELEMENT	RANGE PPM	ELEMENT	RANGE PPM
Ag	5ppm	Cu	0.01	Pb	0.01
Cd	5ppm	Fe	0.01	Zn	0.01
Co	0.01	Ni	0.01		

Ore grade 4 acid digest / AAS first element  
/ per additional element

4AH2/AA

#### Four Acid Ore Grade ICP-OES Package

ELEMENT	RANGE PPM	ELEMENT	RANGE PPM	ELEMENT	RANGE PPM
Ag	0.5	K	0.01%	Sn	10
Al	0.01%	La	1	Sr	1
As	5	Li	1	S	50
Ba	2	Mg	0.01%	Ta	5
Bi	5	Mn	2	Te	10
Ca	0.01%	Mo	1	Ti	0.01%
Cd	1	Na	0.01%	V	1
Co	2	Nb	5	W	10
Cr	2	Ni	1	Y	1
Cu	2	Pb	2	Zn	2
Fe	0.01%	Sb	5	Zr	5
Ga	10	Sc	2		

ICP-OES package 4 acid ore grade digestion

4AH2/OE201

#### Four Acid Ore Grade ICP-OES Individual Elements

ICP-OES elements are available individually. Please see table above for elements and detection limits.

DESCRIPTION	CODE
Four Acid Ore Grade / ICP-OES first element / per additional element	4AH2/OM

#### Specialised and Classical Methods

ANALYTE	DESCRIPTION	CODE
Acid soluble Cu	Dilute H <sub>2</sub> SO <sub>4</sub> leach / AAS	AS/AA
Cyanide soluble Cu	Ambient temperature cyanide leach / AAS	CU1/AA
Cu in Cu concentrates	Short iodide titration	CU2/VOL
Zn in Zn concentrates	EDTA titration	ZN1/VOL

LEGEND		
Complete recovery for most samples	Near complete recovery for most samples	Not complete recovery

## SPECIFIC COMMODITIES

### IRON ORE

X-ray fluorescence spectroscopy (XRF) is the preferred method of analysis for iron ore samples. Accuracy, long term reproducibility and high throughput means XRF is unparalleled in the modern geochemical laboratory for the analysis of the major components of iron ores.

Pulverised samples are fused with a lithium borate flux and cast into disks using semi or fully automated technology. The use of fusion disks eliminates physical effects such as particle size and reduces matrix effects which can compromise the accuracy of XRF analysis. High quality data is produced using either simultaneous or sequential wavelength dispersive instrumentation.

Single point Loss on Ignition (LOI) is determined at 1000°C and is included in the analytical package rate. Customised multiple point LOI analysis, as determined by Thermo Gravimetric Analysis (TGA), are available on request.

#### Basic Iron Ore XRF Package

Suitable for exploration and resource modeling this suite is intended to quantify the essential major and minor oxide components of an iron ore sample.

ELEMENT	RANGE %	ELEMENT	RANGE %	ELEMENT	RANGE %
Fe <sub>2</sub> O <sub>3</sub>	0.01 - 100	MgO	0.01 - 100	SiO <sub>2</sub>	0.01 - 100
Al <sub>2</sub> O <sub>3</sub>	0.01 - 100	MnO	0.01 - 100	TiO <sub>2</sub>	0.01 - 100
CaO	0.01 - 100	Na <sub>2</sub> O	0.01 - 100	V <sub>2</sub> O <sub>5</sub>	0.005 - 10
Cr <sub>2</sub> O <sub>3</sub>	0.005 - 10	P	0.001 - 45	LOI 1000°C	0.01 - 100
K <sub>2</sub> O	0.01 - 100	S	0.001 - 40		
Li borate fusion / XRF Additional LOI				FB1/XRF210 FB1/XRF210-1	

#### Extended Suite Packages

Suitable for exploration and resource modeling as well as quantification of additional accessory and deleterious elements. These elements are less abundant in most iron ores however, they may affect the quality of the ore if present in significant quantities.

#### Iron Ore Extended Suite - Standard Detection Limits XRF Package

ELEMENT	RANGE %	ELEMENT	RANGE %	ELEMENT	RANGE %
Fe <sub>2</sub> O <sub>3</sub>	0.01 - 100	Cu	0.005 - 5	S	0.001 - 40
Al <sub>2</sub> O <sub>3</sub>	0.01 - 100	K <sub>2</sub> O	0.01 - 100	SiO <sub>2</sub>	0.01 - 100
As	0.005 - 5	MgO	0.01 - 100	Sn	0.005 - 5
BaO	0.005 - 5	MnO	0.01 - 100	TiO <sub>2</sub>	0.01 - 100
CaO	0.01 - 100	Na <sub>2</sub> O	0.01 - 100	V <sub>2</sub> O <sub>5</sub>	0.005 - 10
Cl	0.005 - 5	Ni	0.005 - 20	Zn	0.005 - 5
Co	0.005 - 5	P	0.001 - 45	LOI 1000°C	0.01 - 100
Cr <sub>2</sub> O <sub>3</sub>	0.005 - 10	Pb	0.005 - 5		
Li borate fusion / XRF Additional LOI				FB1/XRF211 FB1/XRF211-1	

Multi-point LOI values are cumulative unless requested otherwise.

### ALUMINIUM ORE (BAUXITE)

XRF analysis of bauxite is the preferred method to return total values of the component oxides such as alumina and silica. A single point LOI is done at 1000°C. As bauxites are highly hygroscopic, all data is corrected to the dry sample.

Of more fundamental importance are the available alumina and reactive silica components of the bauxite ores. The available alumina is the alumina component that can be extracted using the sodium hydroxide leaching Bayer process. The reactive silica is the silica component that dissolves in the Bayer process and reacts with some of the dissolved alumina and sodium hydroxide, whereby both alumina and sodium are lost to the process. Reactive silica and available alumina are determined in the Perth dedicated bauxite analysis facility.

#### Bauxite XRF Package

ELEMENT	RANGE %	ELEMENT	RANGE %	ELEMENT	RANGE %
Al <sub>2</sub> O <sub>3</sub>	0.01 - 100	MgO	0.01 - 100	TiO <sub>2</sub>	0.01 - 100
BaO	0.01 - 100	MnO	0.01 - 100	V <sub>2</sub> O <sub>5</sub>	0.005 - 100
CaO	0.01 - 100	Na <sub>2</sub> O	0.01 - 100	ZrO <sub>2</sub>	0.01 - 100
Cr <sub>2</sub> O <sub>3</sub>	0.005 - 100	P <sub>2</sub> O <sub>5</sub>	0.002 - 100	LOI 1000°C	0.01 - 100
Fe <sub>2</sub> O <sub>3</sub>	0.01 - 100	SiO <sub>2</sub>	0.01 - 100		
K <sub>2</sub> O	0.01 - 100	S	0.002 - 2		
Li borate fusion / XRF				FB1/XRF230	

## CHROMITE ORE

Chromium ores are usually found associated with ultramafic rocks and may be accurately analysed by fusion XRF with a single point LOI (1000°C). The highly refractory nature of chromite ores requires a specialist approach in the fusion process to ensure that the spinel structure is decomposed and the entire sample is dissolved in the fusion disk. The LOI is usually negative in higher grade ores due to the oxidation of ferrous iron in the spinel structure. The major element analysis can be used to classify the chromite ore.

### Chromite Ore XRF Package

ELEMENT	RANGE %	ELEMENT	RANGE %	ELEMENT	RANGE %
Cr <sub>2</sub> O <sub>3</sub>	0.005 - 100	MgO	0.01 - 100	S	0.002 - 2
Al <sub>2</sub> O <sub>3</sub>	0.01 - 100	MnO	0.01 - 100	TiO <sub>2</sub>	0.01 - 100
CaO	0.01 - 100	Na <sub>2</sub> O	0.01 - 100	V <sub>2</sub> O <sub>5</sub>	0.005 - 100
Fe <sub>2</sub> O <sub>3</sub>	0.01 - 100	P <sub>2</sub> O <sub>5</sub>	0.002 - 100	LOI 1000°C	0.01 - 100
K <sub>2</sub> O	0.01 - 100	SiO <sub>2</sub>	0.01 - 100		

Li borate fusion / XRF

FB1/XRF235

## NICKEL LATERITE ORES

The oxidised nature of nickel laterite ore and the low sulphur contents make XRF with a single point LOI an ideal technique for the chemical characterisation of these ores. XRF can accurately quantify the nickel and cobalt contents of the ore, important trace elements such as cobalt and zinc, as well as the major oxide components which are used to classify the laterite ore type. Nickel laterite ores can be hygroscopic with high moisture contents. Moisture is therefore corrected for routinely and all results are reported on a dry basis.

### Nickel Laterite Ore Standard XRF Package

ELEMENT	RANGE %	ELEMENT	RANGE %	ELEMENT	RANGE %
Ni	0.01 - 25	Cr <sub>2</sub> O <sub>3</sub>	0.005 - 10	P <sub>2</sub> O <sub>5</sub>	0.002 - 15
Al <sub>2</sub> O <sub>3</sub>	0.01 - 50	Fe <sub>2</sub> O <sub>3</sub>	0.01 - 95	SiO <sub>2</sub>	0.01 - 100
CaO	0.01 - 55	MgO	0.01 - 50	TiO <sub>2</sub>	0.01 - 48
Co	0.005 - 5	MnO	0.01 - 30	LOI 1000°C	0.01 - 100

Li borate fusion / XRF

FB1/XRF240

### Nickel Laterite Ore Extended XRF Package

ELEMENT	RANGE %	ELEMENT	RANGE %	ELEMENT	RANGE %
Ni	0.005 - 20	Cr <sub>2</sub> O <sub>3</sub>	0.005 - 100	P <sub>2</sub> O <sub>5</sub>	0.002 - 100
Al <sub>2</sub> O <sub>3</sub>	0.01 - 100	Fe <sub>2</sub> O <sub>3</sub>	0.01 - 100	SiO <sub>2</sub>	0.01 - 100
CaO	0.01 - 100	K <sub>2</sub> O	0.01 - 100	SO <sub>3</sub>	0.002 - 100
Cl	0.002 - 2	MgO	0.01 - 100	TiO <sub>2</sub>	0.01 - 100
Co	0.005 - 5	MnO	0.01 - 100	Zn	0.005 - 5
Cu	0.005 - 5	Na <sub>2</sub> O	0.01 - 100	LOI 1000°C	0.01 - 100

Li borate fusion / XRF

FB1/XRF241

## MANGANESE ORE

XRF, with a single point LOI (1000°C), is routinely used in the accurate quantification of the chemical components of manganese ores. A complete suite is analysed which includes lead and barium. These two elements can be important components of the ore and the concentrations of these elements are required to do the requisite matrix corrections in the XRF analysis.

### Manganese Ore XRF Package

ELEMENT	RANGE %	ELEMENT	RANGE %	ELEMENT	RANGE %
MnO	0.01 - 100	Fe <sub>2</sub> O <sub>3</sub>	0.01 - 100	SiO <sub>2</sub>	0.01 - 100
Al <sub>2</sub> O <sub>3</sub>	0.01 - 100	K <sub>2</sub> O	0.01 - 100	S	0.002 - 2
BaO	0.01 - 100	MgO	0.01 - 100	TiO <sub>2</sub>	0.01 - 100
CaO	0.01 - 100	Na <sub>2</sub> O	0.01 - 100	V <sub>2</sub> O <sub>5</sub>	0.005 - 100
Cr <sub>2</sub> O <sub>3</sub>	0.005 - 100	P <sub>2</sub> O <sub>5</sub>	0.002 - 100	LOI 1000°C	0.01 - 100
Cu	0.005 - 5	Pb	0.005 - 5		

Li borate fusion / XRF

FB1/XRF256

## INDUSTRIAL MINERALS

XRF is a very useful technique for the analysis of diverse rock types and is the favored routine method for the full chemical characterisation of assorted industrial mineral feedstocks and products such as attapulgite, kaolinite, pyrophyllite, limestone, dolomite, phosphates, cement, mica and feldspar.

### Clays, Limestones & Dolomites

Clay, Limestone & Dolomite XRF Package - suitable for samples containing <500ppm uranium.

ELEMENT	RANGE %	ELEMENT	RANGE %	ELEMENT	RANGE %
Al <sub>2</sub> O <sub>3</sub>	0.01 - 100	MgO	0.01 - 100	S	0.002 - 2
CaO	0.01 - 100	MnO	0.01 - 100	TiO <sub>2</sub>	0.01 - 100
Cr <sub>2</sub> O <sub>3</sub>	0.01 - 100	Na <sub>2</sub> O	0.01 - 100	LOI 1000°C	0.01 - 100
Fe <sub>2</sub> O <sub>3</sub>	0.01 - 100	P <sub>2</sub> O <sub>5</sub>	0.002 - 100		
K <sub>2</sub> O	0.01 - 100	SiO <sub>2</sub>	0.01 - 100		
Li borate fusion / XRF				FB1/XRF250	
Li borate fusion / XRF				FB1/XRF260	

### Zircon Sand XRF Package

ELEMENT	RANGE %	ELEMENT	RANGE %	ELEMENT	RANGE %
ZrO <sub>2</sub>	0.01 - 100	HfO <sub>2</sub>	0.02 - 5	P <sub>2</sub> O <sub>5</sub>	0.01 - 15
Zr	0.01 - 74	K <sub>2</sub> O	0.01 - 5	SiO <sub>2</sub>	0.01 - 100
Al <sub>2</sub> O <sub>3</sub>	0.01 - 29	MgO	0.01 - 25	TiO <sub>2</sub>	0.01 - 10
CaO	0.01 - 30	MnO	0.01 - 30	LOI 1000°C	0.01 - 10
Fe <sub>2</sub> O <sub>3</sub>	0.01 - 30	Na <sub>2</sub> O	0.01 - 3		
Li borate fusion / XRF				FB1/XRF256	

## COPPER

A spectrum of analytical techniques are offered that add value to the copper industry supply chain. These include ultra-sensitive exploration methods, ore grade characterization and empirical digestion techniques that target copper in different forms. Acid soluble copper refers to the metal content extractable using dilute sulphuric acid. This includes the most common oxide copper species malachite, azurite and chrysocolla. Other copper minerals may also be partially dissolved. Cyanide soluble copper includes most oxide minerals, common sulphide minerals but not chalcopyrite. These techniques are empirical in that the recovery depends on the conditions of the digest, the degree of comminution and the deportment of the metal in the ore. Total copper is offered by four acid digest. Umpire and commercial exchange assay services are available at Intertek's specialist LSI laboratory, see Minerals Trade Services.

### Specialised Copper Methods

ELEMENT	DESCRIPTION	RANGE	CODE
Cu	Aqua regia digest / ICP-OES	1 - 1%	Cu-AR1/OE
Cu	4 acid digest / ICP-OES for more complete digestion of complex matrices	1 - 2%	Cu-4A/OE
Cu	Ore grade 4 acid digest / ICP-OES	5 - 70%	Cu-4AO/OE
Cu	Assay for commercial settlement (Intertek LSI)	-	
Cu	Multi acid digest / short iodide titration	-	Cu-VOL
Cu Acid Soluble	Acid soluble copper (options available)	Various	Cu-AS/OE
Cu CN Soluble	Cyanide soluble copper (options available)	Various	Cu-CN
Cu Sequential	Acid soluble followed by cyanide soluble copper	Various	Cu-SQ

### LEGEND

Complete recovery for most samples

Near complete recovery for most samples

Not complete recovery

# INDIVIDUAL METHODS

ELEMENT	DESCRIPTION	DETECTION LIMIT	CODE
Hg	Specialised acid digest / cold vapour AAS	0.01ppm	HG1/CV
FeO	Acid digestion / titration	0.1%	AD71/VOL

## Gravimetric Determinations

ELEMENT	DESCRIPTION	DETECTION LIMIT	CODE
LOD	Loss on drying (105°C or client nominated temperature)	0.01%	LOD/GR
LOI	Loss on ignition (1000°C or client nominated temperatures)	0.01%	LOI/GR
	Multiple temperatures each additional		

## Carbon and Sulphur Analysis

Carbon and sulphur analyses using a variety of spectroscopic or gravimetric methods with the option of pretreatments for targeting specific forms of the analyte element.

ELEMENT	DESCRIPTION	DETECTION LIMIT	CODE
C,S	Total carbon & sulfur / CS analyser first element	0.01% - 50%	CSA03
	/ per additional element		
C non carbonate	Weak acid digestion / CS analyser 0.01%	0.01% - 50%	C71/CSA

## Sulfur Speciation

Classification of the forms of sulfur present maybe required for certain metallurgical processes. The following method utilizes a carbonate leach to dissolve any soluble sulfate mineralisation and the residual sample is analysed for sulfur.

ELEMENT	DESCRIPTION	DETECTION LIMIT	CODE
S_SCIS	Carbonate Insoluble sulfur	0.01% - 70%	CSA104

# SPECIALISED SERVICES

## MINERALOGY

Applied mineralogy is the study of the mineral phases of materials which contrasts with and complements a traditional chemical analysis. Applied mineralogy identifies the nature of the mineral phase, the grain size and morphology, textures, mineral associations and other parameters. Applied mineralogy has important applications in mineral exploration, mineral processing, mineral waste disposal and treatment, hydrometallurgy, pyrometallurgy and refining. It is also utilised in the oil and gas, coal and environmental industries.

Various ores and commodities can be analysed such as base metal ores, precious metal ores, iron ores, bauxite, chromite, nickel, uranium, rare earths, industrial minerals (including graphite), refractory minerals and clays.

A comprehensive suite of applied mineralogy analyses are available. Please call our Perth laboratory to discuss the options best suited to your requirements with Intertek's XRD specialist.

## BULK MINERALOGY

### X-Ray Diffraction

Powder X-ray diffraction (XRD) is an analytical technique primarily employed for the identification and quantification of crystalline materials in bulk samples, both natural and synthetic.

The results given are either qualitative (descriptive of the sample make-up) or quantitative. Quantitative results can include the non-crystalline (amorphous) content of the sample

### Sample Preparation

#### XRD Crush and Pulverize Package

DESCRIPTION	CODE
Crush -2mm, rotary split 800g, pulverise 800g to < 60µm	XRD13

\*Samples are not to be dried

#### XRD Micronising Package

DESCRIPTION	CODE
Micronising	XRD14

\*Samples are not to be dried

#### XRD Crush, Pulverize and Micronise Package

DESCRIPTION	CODE
Crush -2mm, rotary split 800g, pulverise 800g to <60µm, micronise	XRD15

\*Samples are not to be dried

#### XRD Crush, Pulverize and Micronise Package

DESCRIPTION	CODE
Pulverise <800g to < 60µm, micronise	XRD16

\*Samples are not to be dried

### X-Ray Diffraction Analysis

A number of qualitative and quantitative options are available. Please contact the laboratory to discuss your specific requirements.

ELEMENT	DESCRIPTION	CODE
QUALITATIVE	Qualitative analysis for complete mineralogy	XRDQual
QUANTITATIVE	Quantitative analysis for complete mineralogy (crystalline content only)	XRDQuant
QUANTITATIVE	Quantitative analysis for complete mineralogy and amorphous content	XRDQuant01
QUANTITATIVE	Quantitative analysis for complete mineralogy and amorphous content (2 x Scan analysis)	XRDQuant02

## Clay Mineralogy

Clays are important constituents of soils, mudstones, shales and some ores that often require specialist attention. A range of analytical tests are available, including:

- Clay separation from bulk materials
- Qualitative or quantitative XRD analysis from the bulk sample
- Clay mineral identification (XRD) (from glycolation and heating regimes)

### XRD Clay separation

DESCRIPTION	CODE
Separation of clay fraction, <2 µm	CLAYF
Separation of clay fraction, <2 µm, in iron-rich samples	CLAYFFe

### X-Ray Diffraction Analysis

ELEMENT	DESCRIPTION	CODE
QUALITATIVE	Qualitative analysis of clays (incl. glycolation and heating)	XRDQual01

## INFRA-RED SPECTROSCOPY

### TerraSpec Near-Infrared Spectroscopy (NIR)

The TerraSpec 4 Hi Res spectrometer offers a rapid scan for the identification and characterisation of minerals visible in the NIR range. Minerals and mineral groups include haematite, goethite, garnet, pyroxene, amphibole, epidote, apatite, tourmaline, topaz, clay, mica, chlorite, serpentine, carbonates, hydrous silicates and rare earth minerals. The scan information can be used to identify, characterise and map alteration zones associated with various ore forming processes.

For best results, it is recommended that the characterisation of the mineral analysis be confirmed by XRD analysis on either a continuum or a selected subset of samples.

### ASD Terraspec Scan

DESCRIPTION	CODE
TerraSpec 4 Hi Res scan	NIR
TSG Post processing mineralogy report - standard report (includes scan)	NIR01

### Fourier-Transform Infrared Spectroscopy (FTIR)

Fourier-Transform Infrared Spectroscopy (FTIR) offers a rapid scan technique for the qualitative and quantitative analysis of organic and inorganic materials and minerals. Regression and calibration methods enable quantitative determination of mineralogy. This non-destructive technique requires minimal sample preparation.

DESCRIPTION	CODE
FTIR Scan	FTIR
Qualitative identification	FTIR01
Quantitative determination	FTIR02

## MICRO MINERALOGY

### QEMSCAN

Automated mineralogy via QEMSCAN (Quantitative Evaluation of Minerals by Scanning Electron Microscopy) is used to identify mineral phases, in situ, at the micron scale on polished blocks or thin sections.

As well as identifying the minerals present, the processing of the data allows the visualisation of the textural and spatial arrangements of the minerals. The processing can thus determine grain sizes and shapes as well as provide information for mineral associations, mineral liberation, elemental deportment and elemental mapping.

The technique is best used in conjunction with the bulk mineralogical data obtained from XRD. Please contact us for options.

## MINERALS TRADE SERVICES

Intertek Minerals Trade Services provide independent inspection, sampling, testing and certification services which assist to protect the quantity and quality of mineral commodities to reduce commercial risk in the trading environment. Inspection and testing services are completed to appropriate international standards and procedures.

Non ferrous commercial exchange assay services are provided by Intertek's industry recognised Laboratory Services International (LSI), based in Rotterdam, Netherlands. LSI is an established umpire laboratory providing analytical services to miners, traders and refiners with a long history of expertise in non-ferrous party and umpire analysis and is an industry leader for accuracy, service quality and independence.

In addition, Intertek provides dedicated onsite laboratory services for grade control, process control and shipment samples for iron ore, gold and base metal operations. Iron ore testing facilities are ISO/IEC 17025 accredited for analysis iron ore as per the ISO-9516 Standard.

The global Intertek Minerals Inspection Team also performs risk management and inspection services in load and discharge ports alike, offering a full scope of W/SMD and party assays, in locations from the Americas, Africa to China and the Far East.

### Cargo Inspection Services include:

- Marine cargo surveying
- Loading & discharge superintendence
- Independent ship/cargo damage & repair surveys
- Pre shipment inspection
- Government statutory surveys
- Witness & audit
- Marine consultancy
- Stockpile measurement
- Safety and certification services
- Independent draft surveys
- On hire/off hire/draft/bulk surveys
- Ship vetting services
- P & I surveys
- Foreign trade standards
- Metering & tank calibration
- Loss control
- Marine training

## MINE AND PORT SITE LABORATORIES

Through its dedicated Mine Site Services project team, Intertek is able to provide its clients with a complete solution for any scale of mine or port site laboratory installation, from concept phase to commissioning and contract management. Intertek operates, designs and commissions dedicated mine site laboratories in remote locations to enhance its service to mining operations across multiple mineral commodities.

Intertek's automated and robotic sample systems are purpose built, ranging from individual cells to fully integrated systems providing complete end-to-end sampling to analysis solutions. Intertek Robotic Laboratories (IRL) offers unmatched experience and expertise in the operation of fully automated laboratories in remote locations and is the largest commercial operator of fully automated laboratories.

Outsourcing of a mine-site laboratory offers the benefit of Intertek's world-class expertise and services and enables companies to focus resources and capital on their core business.

### Mine-Site Laboratory Services:

- Sample preparation
- Mineral assay services
- Robotics and automated laboratory systems
- Laboratory outsourcing (build, supply, operate options)
- Consulting services e.g. Laboratory design, laboratory audits, round robins
- Ongoing staffing and technical support

## MINERALS ENVIRONMENTAL TESTING SERVICES

Intertek environmental laboratories support the minerals industry with water, soil and air testing to governmental, regulatory and industry standards.

Minerals environmental services include:

- Water quality
- Ecotoxicology services
- Biological tissue analysis
- Ambient air quality
- Acid sulphate soils
- Environmental baseline studies
- Waste analysis and characterisation
- Sediment and soil analysis
- Soil nutrient analysis
- Air emissions testing
- Acid rock drainage prediction test
- Field sampling and on-site testing

## EXPLORATION AND PRODUCTION SERVICES

From reservoir services and production support, Intertek's analytical and scientific services are focused on extending the longevity of plant and equipment, reducing environmental impacts and optimising operations.

Services include:

- Petroleum geochemistry
- Petrophysics/core analysis
- Environmental chemistry
- Ecotoxicology
- Industrial chemistry

## BUSINESS ASSURANCE

Management systems auditing helps you find and implement best practices for continual improvement, and adds strategic value to your business.

Intertek's comprehensive auditing and certification services provide the tools you need to evaluate and continually improve your business processes.

As an accredited third party registrar, we provide independent verification to ensure that your management system is effective in achieving your business objectives, while also certifying that it meets internationally recognised standards including ISO 9001, ISO 14001 and OHSAS 18001.

Our internal audit, second party supplier audit, and process analysis services will help you proactively monitor performance while saving valuable time and money.

Our services include:

### Management Systems Certification:

- ISO 9001
- ISO 14001
- OHSAS 18001 / AS/NZS 4801

### Supply Chain Assessment & Compliance Programs:

- Workplace Conditions Assessment (WCA)
- Supplier Qualification Programs (SQP)
- Global Security Verification (GSV)

### Environmental & Sustainability Auditing & Certification:

- QC 080000

## INDUSTRY SERVICES

Intertek's Industry Services support the mining, oil and gas, power, construction, engineering, chemical and other heavy industries to manage operational risk and maximise returns. Applying leading inspection, testing, verification and monitoring practices, we assist clients to effectively manage product and process development, regulatory compliance, supply chain integrity and plant and asset maintenance. We enhance our customers' returns from production and manufacturing whilst improving safety, reliability and uptime.

Services include:

- Technical Staffing Services (TSS)
- Technical Inspection Services (TIS)
- Intertek Surveying Services (ISS)
- Asset Integrity Management (AIM)
- Non-Destructive Testing (NDT)

# GENERAL INFORMATION

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## SAMPLE DESPATCH

To assist with the efficient processing of your samples please email all assay instructions and any freight information prior to or at the time of despatch. Sample submissions received without written instructions cannot be processed until adequate written instructions are received from the client.

All discrepancies between submission sheets and actual samples received will be reported prior to commencement of the processing.

We recommend that all submissions of samples are clearly labelled and packaged in a concise and systematic order and are accompanied by accurate and detailed paperwork. To facilitate safe manual handling we would appreciate that samples be packaged in units not exceeding 25kg each. Sample submissions poorly labelled or packaged may incur additional sorting charges. Please "flag" the bag containing the paperwork.

Sample submission pads and pre-addressed stick-on labels are available upon request free of charge. A sample submission form is available from our web site. We offer an online submission service or the option to print a submission to be either emailed or faxed.

The minimum information required on any sample submission sheet is:

1. Client name
2. List or range of sample numbers
3. Sample preparation required
4. Elements required for analysis
5. Methods of analysis preferred
6. Result destination(s)
7. Electronic data format
8. Invoice destination
9. Sample storage requirements
10. Appropriate warnings if any samples are potentially hazardous
11. Indication of any samples that may cause problems during the preparation or analysis. This includes the presence of normally trace elements at percent levels, visible gold, graphitic shales, etc.

Certain samples may require classification as dangerous goods, for the purpose of transport, processing and storage. Compliance is the client's responsibility, please ensure that the samples have been classified, marked and transported in accordance with the requirements of dangerous goods legislation.

**Your co-operation with sample submissions will eliminate unnecessary delays in turnaround.**

## IMPORTATION OF SAMPLES INTO INDONESIA

Indonesia does not possess the same Quarantine import restrictions as found in Australia. However, correct procedures and paperwork must be submitted to minimise delays. Intertek Indonesia has an import licence and your local manager is able to assist clients with the necessary information.

When importing mineral samples into Indonesia from International sources the following document requirements are required; a Commercial Invoice and an Intertek Indonesia Sample Submission Form.

These documents may be downloaded from [www.Intertek.com/minerals](http://www.Intertek.com/minerals) or by contacting the Jakarta Office.

Expenses related to the importation will be charged at cost. Intertek Indonesia does not guarantee that samples submitted will be cleared by Indonesian Customs.

## SERVICE FEES AND SURCHARGES

Intertek Indonesia applies a minimum invoice charge and a batch fee.

When sample submissions include largely differing sample matrices and/or differing analytical requirements, they may be treated as separate submissions and multiple jobs may be generated for each discrete grouping, each possibly attracting minimum job fees or small batch size surcharges.

A waste disposal levy is included in the cost of the analyses that produce lead, alkaline or cyanide based solid or liquid waste that requires specific hazardous waste disposal protocols. Should disposal costs increase prices may be increased accordingly.

Discounts may apply for large batches – please contact Intertek Indonesia to discuss your needs.

## QUALITY ASSURANCE

Regular participation in international, national and internal proficiency round robins and client specific proficiency programs complements KAN ISO 17025 accreditation ensuring international standards are maintained in the laboratories' procedures, methodology, validation, QA/QC and data handling.

Certified Reference Materials and/or in house controls, blanks and replicates are analysed with each batch of samples. These quality control results are reported along with the sample values in the final report. Selected samples are also re-analysed to confirm anomalous results. Prices include the reporting of all QC data except where more than 10% repeats are considered necessary in cases such as poor reproducibility due to particulate gold, in which case additional repeats may be charged for.

Where the concentration of an element exceeds the capacity of the original method selected, re-analysis will be required using a more appropriate technique at the client's expense.

## ETHICS AND COMPLIANCE

Intertek is committed to maintaining the total confidence of its customers and shareholders. One of the Group's primary business objectives is to ensure both compliance with local, national and international laws and the accuracy and validity of reports and certificates that it provides to customers.

The foundations of the policy rest with the Group's employees, each of whom must comply with the company's Code of Ethics and Zero Tolerance policies outlining the high standards expected of them in all business dealings.

Our compliance aims:

- To avoid conflicts of interest and to act openly, responsibly and within the confines of the law and internationally accepted guidelines.
- To implement current 'best practice' policies in all control procedures.
- To maintain a culture in which all employees know what is expected of them.
- To monitor adherence to organisational controls and reporting procedures.
- Compliance is a core component of Intertek's business strategy to ensure high standards of professional conduct and ensure ethical behaviour and integrity of services.

## OCCUPATIONAL HEALTH & SAFETY

Intertek is also committed to the ongoing Health and safety of our employees. In accordance with this commitment, Intertek Indonesia is accredited for OHSAS 18001, ensuring international standards of Occupational Health and Safety are implemented including ongoing OHS training and health monitoring.

## CONVERSION TABLES

### Useful Chemical Conversion Factors

ELEMENT		FACTOR	COMPOUND	ELEMENT		FACTOR	COMPOUND	ELEMENT		FACTOR	COMPOUND
Al	x	1.889	Al <sub>2</sub> O <sub>3</sub>	Fe	x	1.43	Fe <sub>2</sub> O <sub>3</sub>	Pb	x	1.155	PbS
As	x	1.32	As <sub>2</sub> O <sub>3</sub>	Fe	x	1.574	FeS	Rb	x	1.094	Rb <sub>2</sub> O
B	x	3.22	B <sub>2</sub> O <sub>3</sub>	K	x	1.205	K <sub>2</sub> O	Sb	x	1.197	Sb <sub>2</sub> O <sub>3</sub>
Ba	x	1.699	BaSO <sub>4</sub>	La	x	1.173	La <sub>2</sub> O <sub>3</sub>	Si	x	2.139	SiO <sub>2</sub>
Ba	x	1.117	BaO	Li	x	2.153	Li <sub>2</sub> O	Sn	x	1.27	SnO <sub>2</sub>
Be	x	2.775	BeO	Mg	x	1.658	MgO	Sr	x	1.183	SrO
Ca	x	1.399	CaO	Mg	x	3.648	MgCO <sub>3</sub>	Ta	x	1.221	Ta <sub>2</sub> O <sub>5</sub>
Ca	x	2.497	CaCO <sub>3</sub>	Mn	x	1.291	MnO	Th	x	1.138	ThO <sub>2</sub>
Ce	x	1.171	Ce <sub>2</sub> O <sub>3</sub>	Mn	x	1.582	MnO <sub>2</sub>	Ti	x	1.668	TiO <sub>2</sub>
Co	x	1.271	CoO	Mo	x	1.5	MoO <sub>3</sub>	U	x	1.179	U <sub>3</sub> O <sub>8</sub>
Cr	x	1.462	Cr <sub>2</sub> O <sub>3</sub>	Mo	x	1.668	MoS <sub>2</sub>	V	x	1.785	V <sub>2</sub> O <sub>5</sub>
Cs	x	1.06	Cs <sub>2</sub> O	Na	x	1.348	Na <sub>2</sub> O	W	x	1.261	WO <sub>3</sub>
Cu	x	1.252	CuO	Nb	x	1.432	Nb <sub>2</sub> O <sub>5</sub>	Y	x	1.27	Y <sub>2</sub> O <sub>3</sub>
Cu	x	1.252	Cu <sub>2</sub> S	Ni	x	1.273	NiO	Zn	x	1.245	ZnO
F	x	2.055	CaF2	P	x	2.291	P <sub>2</sub> O <sub>5</sub>	Zn	x	1.49	ZnS
Fe	x	1.287	FeO	Pb	x	1.077	PbO	Zr	x	1.351	ZrO <sub>2</sub>

### Common Equivalents

PPM	PPB	%	GRAMS / METRIC TONNE
1	1,000	0.0001	1
10	10,000	0.001	10
100	100,000	0.01	100
1,000	1,000,000	0.1	1,000
10,000	10,000,000	1	10,000

### Drill Core Specifications

DRILL CORE	DIAMETER (MM)	VOLUME PER METER (CM <sup>3</sup> )		
		FULL	HALF	QUARTER
TT	35.0	960	480	240
BQ	36.4	1040	520	260
NQ	47.6	1780	890	445
HQ	63.5	3170	1585	793
BQ3	33.5	880	440	220
NQ3	45.1	1600	800	400
HQ3	61.1	2930	1465	733
Mass (g) = Volume/meter x SG x length (m)				

[illegible]

## INTERTEK MINERALS SERVICES TERMS AND CONDITIONS (2016)

- 1.0 Unless otherwise specifically agreed in writing Intertek Minerals (hereinafter called "the Company") undertakes services in accordance with these general conditions (hereinafter called "General Conditions") and accordingly all offers or tenders of service are made subject to these General Conditions. All resulting contracts, agreements or other arrangements will in all respects be governed by these General Conditions, except only to the extent that the law of the place where such arrangements or contracts are made or carried out shall preclude any of the General Conditions and in such case such local law shall prevail wherever, but only to the extent that, it is at variance with these General Conditions.
- 1.1 For the purposes of these conditions the term "Intertek Minerals" comprises all of the Intertek subsidiaries carrying out Minerals testing and inspection activities including but not limited to Intertek, Intertek Minerals, Intertek Genalysis, Intertek Testing Services (Australia) Pty Ltd, Intertek Robotic Laboratories Pty Ltd, (IRL), PT Intertek Utama Services (IUS), ITS (PNG) Ltd, Genalysis Laboratory Services Pty Ltd, Genalysis Laboratory Services SA Pty Ltd, Intertek NTEL, Intertek Minerals Limited, Intertek Testing Services Philippines Inc, Intertek Genalysis Namibia (Pty) Ltd, Intertek International Tanzania Ltd, ITS West Africa, Intertek Commodities Botswana, Intertek Genalysis Zambia Ltd, Intertek Genalysis SI Ltd, Intertek Vigalab SpA, Laboratory Services International, B.V (LSI).
- 2.0 The Company is an enterprise engaged in the trade of inspection and testing. As such, it:
- 2.1 carries out such standard services as are referred to in General Condition 6;
- 2.2 renders advisory and special services as may be agreed by the Company and as referred to in General Condition 7; and
- 2.3 issues reports and/or certificates as referred to in General Condition 8
- 3.0 The Company acts for the persons or bodies from whom the instructions to act have originated (hereinafter called "the Principal"). No other party is entitled to give instructions, particularly on the scope of inspection or delivery of report or certificate, unless so authorized by the Principal and agreed by the Company. The Company will however be deemed irrevocably authorized to deliver at its discretion the report or the certificate to a third party if following instructions by the Principal a promise in this sense had been given to this third party or such a promise implicit follows from circumstances, trade custom, usage or practice.
- 4.0 The Company will provide services in accordance with:
- 4.1 the Principal's specific instructions as confirmed by the Company;
- 4.2 the terms of the Company's Standard Order Form, Sample Submission Form and/or Standard Specification Sheet if used;
- 4.3 any relevant trade custom, usage or practice; and
- 4.4 such methods as the Company shall consider appropriate on technical, operational and/or financial grounds.
- 5.0 5.1 All enquiries and orders for the supply of services must be accompanied by sufficient information specifications and instructions to enable the Company to evaluate and/or perform the services required.
- 5.2 Documents reflecting engagements contracted between the Principal and third parties, or third parties' documents, such as copies of contracts of sale, letters of credit, bills of lading, etc., are (if received by the Company) considered to be for information only, without extending or restricting the mission or obligations accepted by the Company.
- 6.0 The Company's standard services may include all or any of the following:
- 6.1 quantitative and/or qualitative inspection;
- 6.2 inspection of goods, plant, equipment, packing, tanks, containers and means of transport;
- 6.3 inspection of loading or discharging;
- 6.4 sampling;
- 6.5 laboratory analysis or other testing; and
- 6.6 surveys and audits.
- 7.0 Special services where the same exceed the scope of standard services as referred to in General Condition 6 will only be undertaken by the Company by particular arrangement.
- Such special services are illustratively not exhaustively:
- 7.1 qualitative and/or quantitative guarantees;
- 7.2 supply of technicians and other personnel;
- 7.3 pre-shipment inspection under government mandated import or customs schemes; and
- 7.4 advisory services.
- 8.0 8.1 Subject to the Principal's instructions as accepted by the Company, the Company will issue reports and certificates of inspection which reflect statements of opinion made with due care within the limitation of instructions received but the Company is under no obligation to refer to or report upon any facts or circumstances which are outside the specific instructions received.
- 8.2 Reports or certificates issued following testing or analysis of samples contain the Company's specific opinion on those samples as received only but do not express any opinion upon the bulk from which the samples were drawn. If an opinion on the bulk is requested special arrangements must be made in advance with the Company for the inspection and sampling of the bulk.
- 9.0 The Principal will:
- 9.1 ensure that instructions to the Company and sufficient information are given in due time to enable the required services to be performed effectively;
- 9.2 procure all necessary access for the Company's representatives to enable the required services to be performed effectively;
- 9.3 supply, if required, any special equipment and personnel necessary for the performance of the required services;
- 9.4 ensure that all necessary measures are taken for safety and security of working conditions, sites and installations during the performance of services and will not rely, in this respect, on the Company's advice whether requested or not;
- 9.5 take all necessary steps to eliminate or remedy any obstruction to or interruptions in the performance of the required services;
- 9.6 inform the Company in advance of any known hazards or dangers, actual or potential, associated with any order or samples or testing including, for example, presence or risk of radiation, toxic or noxious or explosive elements or materials, environmental pollution or poisons; and
- 9.7 fully exercise all its rights and discharge all its liabilities under any related contract whether or not a report or certificate has been issued by the Company failing which the Company shall be under no obligation to the Principal.
- 10.0 The Company shall be entitled at its discretion to delegate the performance of the whole or any part of the services contracted for with the Principal to any agent or subcontractor. Where deemed appropriate by the company, prior consent will be sought from the Principal.
- 11.0 If the requirements of the Principal necessitate the analysis of samples by the Principal's or by any third party's laboratory the Company will pass on the result of the analysis but without responsibility for its accuracy. Likewise where the Company is only able to witness an analysis by the Principal's or by any third party's laboratory the Company will provide confirmation that the correct sample has been analysed but will not otherwise be responsible for the accuracy of any analysis or results.

- 12.0 12.1 The Company undertakes to exercise due care and skill in the performance of its services and accepts responsibility only where such skill and care is not exercised.
- 12.2 All samples submitted to the Company remain the property of the principle. The Company shall not be liable for any claim whatsoever relating to deterioration, contamination, damage or loss of samples. The Principle indemnifies the Company against any claims or legal action resulting from damage, deterioration or loss of samples.
- 12.3 The liability of the Company in respect of any claims for loss, damage or expense of whatsoever nature and howsoever arising in respect of any breach of contract and/or any failure to exercise due skill and care by the Company shall in no circumstances exceed a total aggregate sum equal to Fifteen (15) times the amount of the fee or commission paid or payable in respect of the specific service or test required under the particular contract with the Company which gives rise to such claims, or US\$15,000, whichever is least, provided however that the Company shall have no liability in respect of any claims for indirect or consequential loss including loss of profit and/or loss of future business and/or loss of production and/or cancellation of contracts entered into by the Principal. Where the fee or commission payable relates to a number of services and a claim arises in respect of one of those services the fee or commission may be apportioned for the purposes of this paragraph by reference to the estimated time involved in the performance of each service or the value of the individual services.
- 12.4 The limit of liability of the Company under the terms of Condition 12.2 may be increased upon request received by the Company in advance of the performance of the service to such figure as may be agreed upon payment of additional fees equal to an appropriate fraction of the increase in such compensation or as may be agreed upon.
- 13.0 The Principal shall guarantee, hold harmless and indemnify the Company and its officers, employees, agents or subcontractors against all claims made by any third party for loss, damage or expense of whatsoever nature and howsoever arising relating to the performance, purported performance or non-performance of any services to the extent that the aggregate of any such claims relating to any one service exceed the limit mentioned in Condition 12.
- 14.0 Every officer, employee, agent or subcontractor of the Company shall have the benefit of the limitation of compensation and the indemnity contained in these General Conditions and so far as relates to such limitations any contract entered into by the Company is entered into not only on its own behalf but also as agent and trustee for every such person as aforesaid.
- 15.0 In the event that any unforeseen problems or expenditure arise in the course of carrying out any of the contracted services the Company shall be entitled to make reasonable additional charges to cover additional time and cost necessarily incurred to complete the service.
- 16.0 16.1 The Principal will punctually pay not later than Thirty (30) days after the relevant invoice date or upon receipt of invoice where credit is not extended or a credit limit is exceeded or within such other period as may have been agreed in writing by the Company all proper charges rendered by the Company failing which interest will become due at the rate of Eighteen per cent (18%) per annum or one and a half percent (1.5%) from the date of invoice until payment.
- 16.2 The Principal shall not be entitled to retain or defer payment of any sums due to the Company on account of any dispute, cross claim or set off which it may allege against the Company.
- 16.3 In the event of any suspension of payment arrangement with creditors, bankruptcy, insolvency, receivership or cessation of business by the Principal the Company shall be entitled to suspend all further performance of its services forthwith and without liability.
- 17.0 In the event of the Company being prevented by reason of any cause whatsoever outside the Company's control from performing or completing any service for which an order has been given or an agreement made, the Principal will pay to the Company:
- 17.1 the amount of all abortive expenditure actually made or incurred; and
- 17.2 a proportion of the agreed fee or commission equal to the proportion (if any) of the service actually carried out and the Company shall be relieved of all responsibility whatsoever for the partial or total non-performance of the required service
- 18.0 The Company shall be discharged from all liability to the Principal for all claims for loss, damage or expense unless suit is brought within twelve (12) months after the date of the performance by the Company of the service which gives rise to the claim or in the event of any alleged non-performance within three (3) months of the date when such service should have been completed.
- 19.0 The Company is neither an insurer nor a guarantor and disclaims all liability in such capacity. Principals seeking a guarantee against loss or damage should obtain appropriate insurance.
- 20.0 No alteration, amendment or waiver of any of these General Conditions shall have any effect unless made in writing and signed by an officer of the Company
- 21.0 Upon completion of testing the company shall provide a report to the principal on the results of the testing. Where requested by the Principal provisional results may be provided however the Principal agrees that those results shall be subject to confirmation in a final report.
- 22.0 The company agrees to take reasonable measures to ensure that the results of Inspection or Testing on behalf of the Principal and any other information provided to the company are kept confidential provided that this provision will not apply where the results or other information are in the public domain.
- 23.0 The Company shall have no responsibility for any action or inaction of any carrier, shipping or delivering any sample to or from the Company premises.
- 24.0 Samples shall be stored free of charge for a period of sixty (60) days after provision of the invoice. Upon expiration of the free storage period, unless otherwise directed by the Principal storage fees and/or disposal charges shall apply.
- 25.0 All data will be retained for a seven (7) year period; fees may apply for retrieval of data if longer than three (3) months after the final report date.



## GLOBAL LOCATIONS

### ASIA PACIFIC

#### Indonesia

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Inspection Services are available at all major ports & distribution centres. website on up to date information on locations, services and fact sheets [www.intertek.com/minerals/](http://www.intertek.com/minerals/)

## NOTES

## NOTES



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**GENALYSIS**  
LABORATORY SERVICES