

# GEOCHEMISTRY

2021 SCHEDULE OF  
SERVICES & FEES  
\$ CAD



BUREAU  
VERITAS



# BUREAU VERITAS SERVICES & FEES

## PARTNER TO THE GLOBAL MINING INDUSTRY

Bureau Veritas Minerals (BVM) is the leading global provider of geochemistry, geoanalytical, mineral processing and environmental services to the exploration and mining community. We are by your side throughout the mining value chain: exploration, extraction, processing and transportation. Our services are structured to support the life cycle of your assets, from planning and design through procurement of components and equipment to construction and operation:

- **REDUCE RISK** in your construction projects through safety assessments, supervision and quality assurance.
- **ACHIEVE CONSISTENT QUALITY** by controlling your supply chain and processes.
- **REASSURE LOCAL STAKEHOLDERS** by demonstrating conformity with regulations and standards.
- **PRESERVE THE LIFE** of your assets through Asset Integrity Management, inspection and non-destructive testing.
- **OPTIMIZE THE EFFICIENCY** of your operations and maintenance activities.
- **ACCESS EXPERTISE** throughout the world thanks to our global network of Technical Centers.



# BUREAU VERITAS SERVICES & FEES

## QUALITY ASSURANCE QUALITY CONTROL

At Bureau Veritas Minerals (BVM) our core product is analytical data. Over many years, we have invested heavily in proprietary software and staff development to ensure that you get the highest quality data. BVM has implemented a comprehensive quality management system meeting the requirements of ISO/IEC 17025 to ensure the necessary processes and oversight are in place to achieve this goal.



### QUALITY ASSURANCE

Through the process of external auditing by recognized organizations, our facilities maintain ISO 17025 accreditation. This accreditation provides independent verification that the management system has been implemented and meets the requirements of the standard. All analytical hubs have received ISO/IEC 17025 accreditation for specific laboratory procedures and sample preparation facilities are monitored to ensure compliance with quality control and quality assurance requirements for off site preparation.



### AUDIT PROGRAM

All BVM facilities are also internally audited against the above ISO standard by knowledgeable and trained personnel on a scheduled basis.



### PROFICIENCY TESTING PROGRAMS

BVM laboratories routinely participate in national and international inter-laboratory comparison studies in order to independently assess individual laboratory performance for the test method(s) analyzed.



### QUALITY CONTROL

Through comprehensive training, BVM ensures that laboratory staff are competent to perform the analysis requested. All labs use validated methods to achieve accurate reproducible results with equipment that is maintained and calibrated to achieve the highest levels of performance. At all steps of sample handling, the laboratory maintains traceability of samples through the use of barcode tracking and maintains detailed audit trails of the people and equipment used to perform analysis.



### ■ IN SAMPLE PREPARATION

As one of the most critical steps in the sample analysis process, BVM continually monitors the efficiency of crushing and pulverizing to ensure that a representative portion of each sample submitted is prepared. Sample duplicates are created and analyzed for all rock and drill core samples submitted.



### ■ IN ANALYSIS

In addition to routine calibration solutions the laboratory inserts reference materials, replicates and blanks into randomly assigned positions within each analytical rack generated by our proprietary LIMS. These QC materials provide a final verification of the entire analytical process.



### ■ IN DATA REVIEW AND EVALUATION

This is the final layer that is made up of sophisticated proprietary software and professional personnel reviewing the data.

For more information on the BVM Quality program, refer to the guidance document BVM Quality Control: Definitions and Guidelines for the Interpretation of Quality Control.

# BUREAU VERITAS SERVICES & FEES

## INFRARED SPECTROSCOPY

### INFRARED SPECTRAL ANALYSIS AND MACHINE LEARNING

As an exploration project transitions to a mining project, one of the most expensive stages from an analytical perspective is process and mine development and, to a lesser degree, mine production. Many of the geochemical, mineralogical, or physical tests at these stages are costly, thus fewer dominated samples are analyzed. Assays become poor proxies for metallurgical characteristics in a block model. Bureau Veritas Minerals' spectral service (VNIR to TIR) plus machine learning can help to optimise resource development by predicting properties that are difficult, costly or time consuming to measure. This analytical technology measures light absorbed by a sample in the infrared (IR) region of the light spectrum [spectral range of VNIR-SWIR-LWIR-TIR (0.35 to 26.5  $\mu\text{m}$ )]. As this technology covers a large wavelength range, it has the ability to predict a diverse range of mineralogical and metallurgical parameters.

Bureau Veritas has successfully completed bauxite, iron ore, base metals, precious metals, and porphyry copper spectral programs. Our service can predict mineralogy, physical properties, ore processing properties, ore classification, geochemistry, and more.

CYCLE	SCOPE OF WORK	ANALYSIS TYPE	ANALYSIS COST	ANALYSIS VOLUMES
Exploration	Geo Assay Mineralogy Ore Characterization	Low Detection Levels Pathfinders	INNOVATION	Scoping Samples Field Analysis Routine Laboratory
Resource Development	Geo Assay Process Scoping Geomet Studies	Accurate Quantitative Analysis JORC and 43-101 Reporting		Target Samples Routine Laboratory
Process and Mine Development	Feasibility Studies Pilot Plant Product Testing	Mineralogy Recovery Concentrates		Project Samples Research Analysis Proxies
Production	Process Optimisation Product Quality Grade Control Geomet Programs	Tailored Methods for Operations Metal Accounting Transactions		On-Site Lab Fast Turnaround High Accuracy (Trade)

- Bureau Veritas' spectral analysis plus ML workflow involves:
- Normal sample preparation methods are used to produce a dried pulp.
- The IR spectra are collected without any additional preparation. There are no digests, fusions or other processes required.
- Collection of fingerprint IR spectra on a calibration set from a given mineral deposit.
- Data analytics and Machine Learning processes are used to build a custom predictive model.
- The model is validated with spectra from known samples from the same deposit, then deployed to the laboratory for predictions on routine samples.

### HYLOGGER (VNIR AND SWIR) SPECTROMETRY

The Hylogger system can be used on core or rock chips for the qualitative determination of an extensive list of minerals including Fe oxides, ALOH group minerals, sulphates, FeOH group, MgOH group, and carbonates.

#### APPLICATION OF VNIR AND SWIR ANALYSIS:

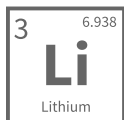
- + Alteration vectoring
- + Lithocap investigations
- + Geometallurgy applications

#### BENEFITS:

- + Cost effective mineralogy
- + Little sample preparation required (analysis can be conducted on core, or chips)
- + Non-destructive
- + Easy set-up, on-site application
- + Hylogger spectra interpretation service is available

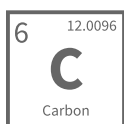
## BATTERY METALS

Bureau Veritas is recognized as a global leader in innovative laboratory testing, inspection, and certification solutions, which serve the businesses that are shaping our changing world.



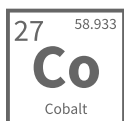
### LITHIUM

Analytical methods suggested: PF370, MA370, ICPTV-W (Solution), Metallurgical and mineralogical services - Ore grade lithium is most commonly found in pegmatites, hectorite clays, and lithium brines. Most of the world's lithium production is in South America, where lithium-containing brine is extracted from underground pools and concentrated by solar evaporation.



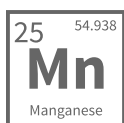
### GRAPHITE

Analytical methods suggested: TC005, TC006, TC007, QEMSCAN & XRD High purity graphite (> 99.95%) is a very important aspect of Li-ion batteries. Currently, approximately 2/3 of all graphite for Li-ion batteries is sourced from natural deposits. The remaining 1/3 is sourced from synthetic processes.



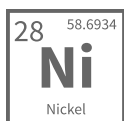
### COBALT

Analytical methods suggested: XF720, PF370, MA370, AQ270-As Currently, the largest cobalt deposits are the stratiform copper/cobalt deposits of the Central African Copper Belt within the Democratic Republic of Congo (DRC). Outside of the DRC, cobalt is typically recovered as a co-product from the mining of magmatic Ni/Cu sulphide and Ni-laterite deposits. The element can also be found in cobalt-silver vein deposits, where it commonly forms Co arsenides. While cobalt grades can be very high in these deposits, so too can arsenic content.



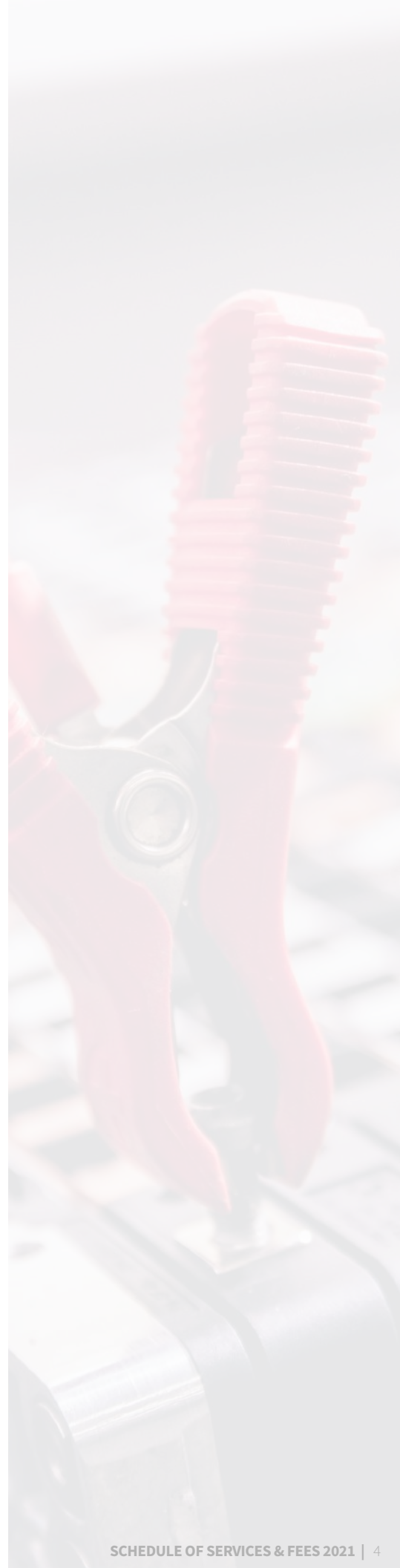
### MANGANESE

Analytical methods suggested: PF370 Manganese ores are generally found in either sedimentary hosted, volcanogenic hosted massive sulphides (VHMS), or karst hosted deposits. Of these 3 types, the sedimentary hosted type is the most common and represents the largest deposits. The majority of Mn ore is mined in South Africa and Australia. Minerals mined are typically braunite, bixbyite, pyrolusite, or hausmannite. Due to the highly refractory nature of these minerals we recommend a very aggressive digestion method.



### NICKEL

Analytical methods suggested: XF720, MA370, MA270, AQ270-As Nickel is generally associated with cobalt. The most common Ni deposits are either magmatic sulphide, or Ni laterites.





## MINE SITE LABORATORY SERVICES

BVM Mine Site Laboratory Services provides high quality customized laboratories supported by our global network of professionals. Our goal is to provide you with a solution that meets your project needs, ranging from a remote mobile prep lab to a full service analytical laboratory at the mine. All labs meet the requirements of ISO 9001 Quality Management Systems and use validated methods and processes which comply with global OH&S standards. As we are the global leader in analytical geochemistry, we will provide you with a customized lab that will minimize costs and liability so your focus can be on mining and exploration.



### ONSITE LABORATORY SERVICES

- + Sample Prep Lab
- + Containerized Lab
- + Full Service Lab



### MINERAL TESTING SERVICES

- + Assaying and geochemical analysis
- + Metallurgical testing services
- + Mineralogical analysis
- + Environmental requirements



### QUALITY & INTEGRITY

- + ISO accredited laboratories
- + Training and onsite laboratory support by qualified BVM Staff
- + Latest production scheduling
- + Auditing of laboratory procedures and management systems



### OUTSOURCING

- + Custom designed facilities to improve sample processing efficiency
- + Technical diagnosis and service repair of existing equipment to reduce costs

# BUREAU VERITAS **SERVICES & FEES**

## WEB ACCESS

WebAccess is a secure web interface for our customers to obtain direct access to the Bureau Veritas Upstream Minerals laboratory database. It allows real-time access to any of your jobs logged into our LIMS. Track your samples from reception through the lab and see results any time of the day or night. Tests that indicate the need for a major inspection are doublechecked prior to your notification.



### **JOB REGISTERING**

Sample submission forms, certificates and invoices



### **TRACKING**

Project documents such as the pricing quote and template submission form



### **ASSAY REPORTS**

Analytical methods documents and reference material certificates



### **QA/QC REPORTS**

Quality Control documents reviewing analytical performance

## **SAMPLE TRACKING SYSTEM**

BVM uses our secure LIMS (Laboratory Information Management System) to track the flow of every sample through each stage of sample handling and analysis. When received, each sample is barcoded and labelled. This unique barcode is used to build an audit trail that documents the complete history of work performed on each sample. It includes the recording of each person that interacted with the sample and the task that they performed. This tracking feature provides the laboratory with a very high level of control but also provides our clients with an unprecedented level of traceability.

## **BOX TRACKING SYSTEM**

Each barcoded sample is allocated into a barcoded sample box. The barcodes allow BVM to track each box as it moves from one laboratory to another and allows our clients to monitor the progress of their samples from a remote sample preparation facility to the main laboratory. More importantly, this system speeds the flow of the samples through the laboratory to eliminate time consuming manual steps and reduces the risk of human error.



# SERVICES & FEES TABLE OF CONTENTS

<b>SAMPLE PREPARATION, STORAGE &amp; DISPOSAL</b>	<b>CODE</b>	<b>8</b>
Crush 70% 10 mesh and pulverize 250 g	PRP70-250	9
Pulverize to 85% passing 200 mesh	PUL85	9
Standard soil sieve 80 mesh	SS80	9
<b>PRECIOUS METALS &amp; LEACHES</b>		<b>12</b>
Fire Assay Au, Pt, Pd – ICP-ES	FA330	13
Fire Assay Au 30 g – AAS finish	FA430	13
Fire Assay Ag 30 g – Gravimetric	FA530-Ag	13
Fire Assay Au 30 g – Gravimetric	FA530-Au	13
Fire Assay Au and Ag 30 g – Gravimetric	FA530	13
Metallic Screen Fire Assay 50 g duplicate minus fraction	FS652	14
<b>ORE &amp; HIGH GRADE ANALYSIS</b>		<b>16</b>
Aqua regia Ore Grade AAS	AR402	17
Multi-acid Ore Grade AAS	MA404	17
Aqua regia Ore Grade ICP-ES	AQ370	18
Multi-acid Ore Grade ICP-ES	MA370	18
Zn Titration	GC816	20
Pb Titration	GC817	20
Fe Titration	GC818	20
Cu Titration	GC820	20
<b>EXPLORATION GEOCHEMISTRY</b>		<b>21</b>
Aqua regia – ICP-ES	AQ300	22
Aqua regia – ICP-ES/MS	AQ200	22
Aqua regia – Ultra-trace	AQ250	23
Multi-acid – ICP-ES	MA300	24
Multi-acid – ICP-ES/MS	MA200	24
Aqua regia – ICP-ES/MS Hg	AQ200-Hg	24
Multi-acid – Ultra-trace	MA250	25
Plant Material Analysis	VG101	27
Generative Exploration Package	GENX10	29
<b>LITHOGEOCHEMISTRY</b>		<b>31</b>
Lithium Borate Fusion – Refractory and REEs	LF100	32
Total Whole Rock Characterization	LF202	32
Whole Rock Lithium Fusion ICP Finish	LF300	32
Leco – Total C and S	TC000	33
XRF – Fusion – Major Oxides	XF700	33
XRF – Fusion – Iron Ore	XF732	34
XRF – Fusion – Laterites	XF720	35
Laser Ablation Package	LA001-EXT + XRF	36
<b>METALLURGY &amp; MINERALOGY</b>		<b>37</b>
Mineral Processing		38
Hydrometallurgy		39
Mineralogy & Petrography		40
<b>ACID ROCK DRAINAGE</b>		<b>41</b>
Geochemical & Mineralogical Testing		42
Static & Sequential Water Extractions		43
Kinetic Testing		44
<b>GLOBAL FOOTPRINT MAP</b>		<b>45</b>





**BUREAU  
VERITAS**

# SAMPLE PREPARATION STORAGE & DISPOSAL

## THE BUREAU VERITAS MINERALS SAMPLE PREPARATION PROCESS INCORPORATES SEVERAL IMPORTANT STEPS. THESE STEPS LAY THE GROUNDWORK FOR ALL ANALYSES

- Sample log-in and reconciliation against the client-supplied list. An electronic reconciliation is sent out for each job, which indicates methods, any potential missing samples, TAT, etc.
- Sample drying.
- Crushing and pulverizing rock, core or other solid media, or sieving soils and sediments. The lab typically crushes the entire sample and the sample mass to be pulverized can be varied based on client preference.
- Most importantly, our labs undertake a rigorous QAQC program to ensure consistent results. A sieve test is used to monitor the process on select and random samples at the primary crushing and pulverizing stage, as well as monitor the wear surfaces of plates, bowls and other equipment problems.

These tests are recorded and produced for your review. If there is a non-conformance in the quality standard, the process is reviewed and corrected. This rigorous policy applies to any material that is reported or used in the analytical process.

## SAMPLE PREPARATION, **STORAGE & DISPOSAL**

The packages listed here are the most common methods applied in our industry. If you require custom sample preparation techniques please contact your local account manager or lab nearest to your project to discuss in more detail. You will find our team of professionals and technical group second to none in our ability to provide support.

### ROCK AND CORE PREPARATION

CODE	DESCRIPTION	CAD
<b>PRP70-250</b>	Crush 1 kg to $\geq 70\%$ passing 2mm - Pulverize 250 g $\geq 85\%$ 75 $\mu$ m Extra crushing over 1 kg, per kg	\$8.90 + \$0.90
<b>PRP70-500</b>	Crush 1 kg to $\geq 70\%$ passing 2mm - Pulverize 500 g $\geq 85\%$ 75 $\mu$ m Extra crushing over 1 kg, per kg	\$9.75 + \$0.90
<b>PRP70-1Kg</b>	Crush 1 kg to $\geq 70\%$ passing 2mm - Pulverize 1 kg $\geq 85\%$ 75 $\mu$ m Extra crushing over 1 kg, per kg	\$11.05 + \$0.90
<b>PRP80-250</b>	Crush 1 kg to $\geq 80\%$ passing 2mm - Pulverize 250 g $\geq 85\%$ 75 $\mu$ m Extra crushing over 1 kg, per kg	\$9.65 + \$1.50
<b>PRP90-250</b>	Crush 1 kg to $\geq 90\%$ passing 2mm - Pulverize 250 g $\geq 85\%$ 75 $\mu$ m Extra crushing over 1 kg, per kg	\$10.05 \$1.90
<b>CRU70</b>	Crush to $\geq 70\%$ passing 2mm per kg, includes first 1 kg Extra crushing over 1 kg, per kg	\$4.15 + \$0.90
<b>CRUPR</b>	Primary Crushing for large samples, (eg. whole core), per kg	\$1.25
<b>PUL85</b>	Dry and pulverize to $\geq 85\%$ passing 75 $\mu$ m Extra pulverizing over 250 g, per 250 g	\$4.35 + \$1.10
<b>DY105</b>	Dry pulp at 105°C, per sample	\$0.75
<b>HOMG</b>	Homogenizing of pulps by light pulverizing	\$4.00
<b>SPTRF</b>	Split by riffle splitter up to 5 kg of -2 mm sample, per sample	\$2.55
<b>WGHT</b>	Weigh sample	\$0.80
<b>CRUBW</b>	Extra wash with barren material – crushing	\$3.00
<b>PULSW</b>	Extra wash – silica – pulverizing	\$4.00
<b>SPTRS</b>	Rotary split up to 5 kg	\$5.25

Other size fractions / preparation requirements available upon request. For example ceramic bowl pulverizing, different size crushing and bowl sizes, etc.

### SOILS

CODE	DESCRIPTION	CAD
<b>SS80</b>	Dry at 60°C, sieve to depletion to -180 $\mu$ m (80 mesh) up to 1 kg sample (discard plus fraction) Overweight sieving per 500 g - extra sieving over 1 kg	\$3.85 \$1.25
<b>SS230</b>	Dry at 60°C, sieve 100 g to -63 $\mu$ m (230 mesh), up to 1 kg sample Overweight sieving per 500 g Other sieve sizes available upon request	\$4.85 \$1.85 BY QUOTE
<b>PULSL</b>	Pulverize soils in mild steel pulverizer, per 100 g	\$3.75
<b>SVRJT</b>	Saving all or part of soil reject	\$1.15
<b>CLYSP</b>	Clay separation up to 500 g (for other weight requirements please contact us)	\$25.00
<b>DISP2</b>	Heat treatment of soils and sediments, per sample (All international soil shipments to Canada)	\$0.60

Important note regarding soils: Importation regulations may apply; contact lab prior to shipment for details and shipment requirements. For soil shipments to Canada: No soil, till, sediment pulps or rejects can be returned and must be incinerated prior to disposal. A disposal fee (DISP2) is charged for these samples. Soil rejects are discarded immediately after preparation unless SVRJT is requested.

## SAMPLE PREPARATION, **STORAGE & DISPOSAL**

### SUBMITTING SAMPLES FOR ANALYSIS

#### SHIPPING INSTRUCTIONS

Go to our website and download our Analysis Request Form (english or spanish available)

- Fill in the form clearly by following step by step instructions (do not alter form format)
- Company information, quote number, project, Shipment ID, name, email and phone number
- Client details, invoice & report
- Mode of data transmittal (CSV, PDF, email)
- Method of analysis desired or package requested
- Special instructions
- Rush service needed
- Storage and disposal (reject or pulps) after analysis
- Don't forget to sign

#### PACKAGING INSTRUCTIONS

- Pack the samples securely, ensuring that each sample is clearly labeled with a sample number.
- Please identify any high grade samples – this helps us to reduce the risk of cross contamination.

#### SOILS INSTRUCTIONS (TO AND WITHIN) CANADA

Bureau Veritas will provide a CFIA Permit needed to clear soil samples expeditiously through Canada Customs. Permits are specific for the country of sample shipment origin and valid for one year. A copy of the permit must accompany each shipment. Shipments cleared through Canada Customs for no charge.

#### ENVIRONMENTAL FEE

As part of our commitment to minimizing the environmental impact of our business activities, Bureau Veritas Minerals has migrated to a single green fee charge to cover all waste charges incurred by the laboratories. This fee, EN004, covers charges for cardboard and plastic recycling, hazardous waste disposal, emissions testing and monitoring, permitting fees and ongoing sustainability initiatives.



CODE	DESCRIPTION	CAD
EN004	Environmental fee charge	\$0.95



## SAMPLE PREPARATION, **STORAGE & DISPOSAL**

### SAMPLE SUBMISSION ANALYSIS

#### SPECIFIC GRAVITY

CODE	DESCRIPTION	CAD
SPG02	Specific Gravity on core by water displacement	\$15.60
	Surcharge over 2 kg	\$5.60
SPG03	Specific Gravity on waxed core (wax removal not included)	\$23.75
SPG04	Density on pulps or rock chips by gas pycnometer	\$16.00

#### MISCELLANEOUS CHARGES

CODE	DESCRIPTION	CAD
PULHP	Hand pulverize by mortar and pestle	\$9.85
QCCHK	Additional QC checks	\$3.75
HAND	Handling of special projects, per hour	\$78.75
SHP-01	Shipping charge (pulps), per sample - from branch (varies by country)	FROM \$2.35
SPTPL	Extra splitting of pulp	\$1.15
PULSW	Extra wash with silica-pulverizing	\$4.00
DYAIR	Air Dry samples, (<40°C), per 2 kg	\$2.85
DYXS	Drying surcharge for excessively wet samples	\$2.20
	Surcharge over, 1 kg, per kg	+ \$0.55
SLBHP	Sorting, Labeling, Boxing and Handling samples received as Pulps	\$1.15
BAT01	Batch charge for <50 samples	\$55.00
VAC01	Vacuum seal samples, nitrogen purge	\$11.80
CRCUT	Core Cutting	BY QUOTE
PICKUP	Shipping charges for samples pick up	BY QUOTE

#### WAREHOUSE CHARGES

CODE	DESCRIPTION	CAD
SPRTRN	Cost of shipping returns	AT COST
DISRJ	Dispose of reject	\$0.85
DISPL	Dispose of pulps	\$0.20
WHRJT	Monthly storage of reject after 60 days	\$0.80
WHPLP	Monthly storage of pulps after 90 days (up to 250 g sample)	\$0.35
WHS01	Warehouse handling, per hour	\$78.75
WHSRT	Monthly storage of soil rejects after 60 days	\$0.45

Storage information: All samples rejects are stored for 2 months and pulps for 3 months at no charge and will be disposed of without notification unless storage is requested at the time of submission. A minimum charge of \$10/ quarter (\$40/yr) will apply to all clients with samples in storage. When storage is requested on receipt, storage will be charged up front to cover the first 6 months. All disposal, handling or shipping charges for concentrates, high norm samples and samples containing hazardous materials will be borne by the client.



**BUREAU  
VERITAS**

## **PRECIOUS METALS & LEACHES**

**METHODS IN THIS SECTION INCLUDE INDUSTRY STANDARD FIRE ASSAY OPTIONS FOR GOLD, SILVER, PLATINUM AND PALLADIUM. FROM A BASIC 30 GRAM CHARGE TO FULL METALLIC SCREEN FIRE ASSAY, RELIABLE DATA IS ACHIEVED FOR ALL SAMPLE TYPES INCLUDING THOSE WITH COARSE GOLD.**

Bulk leaching of gold bearing materials using cyanide is also available and provides an additional tool to evaluate systems with unevenly distributed gold and to test for extractability. Selective and sequential leaches are also included in this section to provide information on the distribution of copper within various phases in the sample.

## PRECIOUS METALS & LEACHES

### AQUA REGIA GOLD

Recommended for soils, sediments, vegetation or reconnaissance rock samples. Samples are digested in 1:1:1 aqua regia then analyzed by ICP-MS. Refractory, massive sulphide and graphitic samples can limit Au solubility.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	DESCRIPTION	CAD
AQ115				15 g Aqua regia ICP-MS	\$15.00
AQ130				30 g Aqua regia ICP-MS	\$17.70
AQ115-IGN	Au	0.5 ppb	10 ppm	Ignited 15 g Aqua regia ICP-MS Rock samples are ignited at 550°C before aqua regia digestion	\$16.80
AQ130-IGN				Ignited 30 g Aqua regia ICP-MS Rock samples are ignited at 550°C before aqua regia digestion	\$19.80

### FIRE ASSAY

Lead collection fire assay fusion is a classic method for total sample decomposition. Total Au content is determined by digesting an Ag dore bead and then analysing by AAS, ICP-ES, or ICP-MS. The Lab reserves the right to reduce sample weight to 15 g or less for proper fusion.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	DESCRIPTION	CAD
<b>ICP-MS</b>					
FA130	Au	1 ppb	1 ppm	30 g / Fire Assay / ICP-MS	\$24.55
FA150	Pt	0.1 ppb	1 ppm	50 g / Fire Assay / ICP-MS	\$27.85
	Pd	0.5 ppb	1 ppm		
<b>ICP-ES</b>					
FA330-Au*	Au	2 ppb	10 ppm	30 g / Fire Assay / ICP-ES	\$19.30
FA350-Au*				50 g / Fire Assay / ICP-ES	\$22.85
FA330*	Au	2 ppb	10 ppm	30 g / Fire Assay / ICP-ES	\$23.00
FA350*	Pt	3 ppb	10 ppm	50 g / Fire Assay / ICP-ES	\$24.60
	Pd	2 ppb	10 ppm		
<b>AAS</b>					
FA430*	Au	0.005 ppm	10 ppm	30 g / Fire Assay / AAS	\$18.75
FA450*				50 g / Fire Assay / AAS	\$21.60
<b>GRAVIMETRIC</b>					
FA530-Ag	Ag	20 ppm	10,000 ppm	30 g / Fire Assay / Gravimetric	\$26.20
FA550-Ag				50 g / Fire Assay / Gravimetric	\$30.00
FA530-Au	Au	0.9 ppm	1,000 ppm	30 g / Fire Assay / Gravimetric	\$26.20
FA550-Au				50 g / Fire Assay / Gravimetric	\$30.00
FA530	Au, Ag	as above	as above	30 g / Fire Assay / Gravimetric	\$26.20
FA550				50 g / Fire Assay / Gravimetric	\$30.00

Require at least 15 g sample weight.

\*Au>10 ppm are automatically analyzed by gravimetric method.



## PRECIOUS METALS & LEACHES

### METALLIC SCREEN FIRE ASSAY

Metallic screen fire assay prices include screening of sample to 106 µm. Additional preparation charges for crushing and pulverizing may apply. Alternative screen sizes/weights available upon request. Pricing is based on gravimetric analysis of the plus fraction and instrumentation on the minus fraction. Additional charges for gravimetric analysis on the minus fraction may apply. Please contact your local office to develop the right package for your project.

CODE	ELEMENT	DETECTION LIMIT	DESCRIPTION	CAD
FS631	Au	0.05 ppm	Metallic Fire Assay single minus fraction analyzed, 30 g - 500 g screen	\$51.45
FS631-1 Kg	Au	0.05 ppm	Metallic Fire Assay single minus fraction analyzed, 30 g - 1 kg screen	\$64.20
FS632	Au	0.05 ppm	Metallic Fire Assay duplicate minus fraction analyzed, 30 g - 500 g screen	\$60.80
FS652	Au	0.05 ppm	Metallic Fire Assay duplicate minus fraction analyzed, 50 g - 500 g screen	\$69.05
FS652-1Kg	Au	0.05 ppm	Metallic Fire Assay duplicate minus fraction analyzed, 50 g - 1 kg screen	\$78.25

### OTHER CHARGES

CODE	DESCRIPTION	CAD
EN004	Environmental fee charge	\$0.95
CHPOT	Stipulate new crucible for fire assay fusion	\$1.65

### WET ASSAY SILVER - ORE GRADE

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	DESCRIPTION	CAD
AR401-Ag	Ag	1 ppm	800 ppm	Aqua Regia Digestion AAS Finish	\$13.40
MA401-Ag	Ag	1 pp-m	800 ppm	Multi-acid Digestion AAS Finish	\$14.90



## PRECIOUS METALS & LEACHES

### PACKAGES FOR REGIONAL NEEDS - CONTACT BEFORE SHIPMENT

**CARBONS, CONCENTRATES & HIGH GRADE** - This method is ideal for the determination of Au and Ag when higher levels of precision are required. Our stringent quality control protocols involve the use of replicate assays and reference materials suited to the analysis to confirm accuracy. Results are not for commercial settlement purposes. Contact Bureau Veritas Commodities – Metals & Minerals Trade for commercial sampling and testing services where results are to be used for commercial settlement and/or financial transactions.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	DESCRIPTION	CAD
FA501-Au	Au	10 ppm	100000 ppm	2 g sample Fire Assay for concentrates, duplicate analyses	\$98.00
FA501-Ag	Ag	100 ppm	100000 ppm	2 g sample Fire Assay for concentrates, duplicate analyses	\$98.00
FA501	Au, Ag	as above	as above	2 g sample Fire Assay for concentrates, duplicate analyses	\$115.80

Note: Additional base metal elements may be added for an additional analytical charge - \*Shipment costs may apply to ship to Reno & Hermosillo

**GOLD BASE METAL LEACHES** - Cyanide leaching can offer an alternative to classic fire assay methods with a comparable low detection limit. However, cyanidation analytical tests provide a more realistic estimation of gold and silver recovery from a rock pulp. Gold recovery can be impacted by organic carbon, graphite, and some sulphide minerals.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	DESCRIPTION	CAD
BL001	Au			Please call to discuss	BY QUOTE
CN400	Ag, Ag, Cu	0.03 ppm	50 ppm	Cyanide leach (various options)	BY QUOTE
CN401	Au	0.03 ppm	50 ppm	15 g, 1 hour room temperature cyanide shake, AAS finish	\$10.85
CN403	Au	0.03 ppm	50 ppm	30 g, 1 hour room temperature cyanide shake, AAS finish	\$12.35
CN401H	Au	0.03 ppm	50 ppm	15 g, 1 hour hot cyanide shake, AAS finish	\$13.55
CN403H	Au	0.03 ppm	50 ppm	30 g, 1 hour hot cyanide shake, AAS finish Extra element	\$14.85 + \$5.50
PL415 PL430	Au	0.03 ppm	50 ppm	Preg rob leach-2 cyanide leaches with and without Au spiked solution • < 15 g sample • 30 g sample	Each leach \$13.35 Each leach \$13.85
GC850		0.01 kg H <sub>2</sub> SO <sub>4</sub> / TON		Sulphuric leach, net acid consumption	\$34.00

Note: Additional base metal elements (Fe, Zn, Pb) may be added to some leaches for an additional analytical charge.

Please contact the laboratory regarding your specific analytical requirements.

**COPPER LEACHES** - The following methods are used for the determination of Cu leachability, mineralogy and mineral solubility. These methods utilize laboratory standard leach conditions; however client specific conditions can be negotiated upon request.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	DESCRIPTION	CAD
LH401	CuS	0.001%	10 %	1M Citric acid leach with AAS finish - Cu oxides	\$14.90
LH402	CuSH	0.001%	10 %	Sulphuric acid leach with AAS finish - nonsulphide Cu	\$14.90
LH403	CuCN	0.01%	10 %	Cyanide leach with AAS finish (1 g)	\$15.95
LH425	CuSAP	0.01%	100 %	Quick ferric sulphate leach for 1hr Cu by AAS	\$13.85
LHSEQ	CuSH CuCN CuRes			Sample is sequentially leached in H <sub>2</sub> SO <sub>4</sub> (LH402), CN (LH403) then Multi-acid, with Cu from each leach reported. Total Copper can be reported as a sum of the leaches.	\$54.30



**BUREAU  
VERITAS**

## ORE & HIGH GRADE ANALYSIS

**BUREAU VERITAS' METHODS ARE DESIGNED TO PROVIDE THE EXTREMELY HIGH PRECISION AND ACCURACY REQUIRED TO QUANTIFY COMMODITY ELEMENTS FOR RESOURCE EVALUATION.**

Methods in this section are designed to provide the high precision and accuracy required to quantify commodity elements for resource evaluation. Digestion methods and reagents are chosen to effectively deal with high analyte concentrations. They are coupled with the most stable and matrix tolerant analytical platforms available to produce data of the highest quality. A variety of classical wet assay methods are also available for samples that exceed the maximum concentrations that can be determined instrumentally.

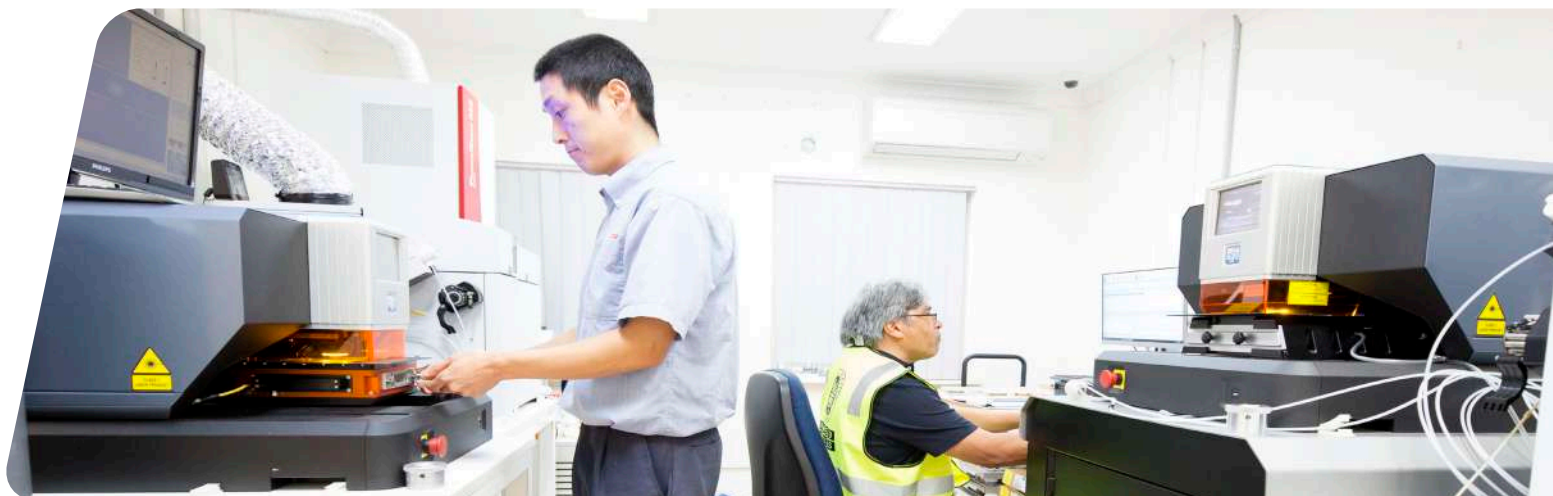


## ORE & HIGH GRADE ANALYSIS

**AAS ANALYSIS** - Aqua regia and multi-acid digestions with AAS analysis are optimized for moderate to high grade ore samples and select target elements. These methods can be set up to be triggered automatically or selected as standalone packages.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
MA401	Ag	1 ppm	800 ppm	\$14.90 for the first element \$4.50 Additional element
	Cu	0.001 %	10 %	
	Fe	0.01 %	10 %	
	Pb	0.01 %	10 %	
	Zn	0.01 %	10 %	
MA401-Mo	Mo	0.001 %	10 %	
	Cu	0.001 %	10 %	
MA404	Ag	2 ppm	1500 ppm	
	Cu	0.01 %	30 %	
	Fe	0.01 %	30 %	
	Ni	0.01 %	30 %	
	Pb	0.01 %	20 %	
	Zn	0.01 %	30 %	

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
AR401	Ag	1 ppm	800 ppm	\$13.40 for the first element \$4.50 Additional element
	Cu	0.001 %	10 %	
AR402	Ag	2 ppm	1000 ppm	
	Cu	0.001 %	10 %	
	Pb	0.01 %	10 %	
	Zn	0.01 %	10 %	
AR404	Ag	2 ppm	1500 ppm	
	Cu	0.001 %	20 %	
	Pb	0.01 %	20 %	
	Zn	0.01 %	20 %	



## ORE & HIGH GRADE ANALYSIS

**ICP Analysis** - The following multi-element assays provide optimum precision and accuracy for high grade rock and drill core samples with a selection of digestion methods to best suit the ore type. AQ370, MA370 and PF370 report percent level concentrations as determined by ICP-ES.

**AQUA REGIA ICP-ES** - Modified Aqua regia digestion for base-metal sulphide and precious metal ores. Aqua regia digestion is considered a partial digestion. Solubility of some elements will be limited by the mineral species present.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>AQ370</b>	<b>Aqua Regia ICP-ES, 24 elements</b>			<b>\$20.65</b>
	Ag	2 ppm	1000 ppm	
	Al	0.01 %	40 %	
	As	0.01 %	10 %	
	Bi	0.01 %	1 %	
	Ca	0.01 %	40 %	
	Cd	0.001 %	1 %	
	Co	0.001 %	1 %	
	Cr	0.001 %	5 %	
	Cu	0.001 %	10 %	
	Fe	0.01 %	40 %	
	Hg	0.001 %	1 %	
	K	0.01 %	40 %	
	Mg	0.01 %	40 %	
	Mn	0.01 %	20 %	
	Mo	0.001 %	5 %	
	Na	0.01 %	25 %	
	Ni	0.001 %	10 %	
	P	0.001 %	25 %	
	Pb	0.01 %	4 %	
	S	0.05 %	30 %	
	Sb	0.001 %	5 %	
	Sr	0.001 %	1 %	
	W	0.001 %	1 %	
	Zn	0.01 %	20 %	
<b>AQ370-X</b>	<b>Aqua Regia ICP-ES, any 1 element</b>			<b>\$14.95</b>

**MULTI-ACID ICP-ES** - Multi-acid digestion for sulphide and silicate ores. This digest approximates a 'total' digest in most samples. Some refractory minerals may not be fully attacked.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>MA370</b>	<b>Multi -acid ICP-ES, 23 elements</b>			<b>\$23.65</b>
	Ag	2 ppm	1500 ppm	
	Al	0.01 %	40 %	
	As	0.02 %	10 %	
	Bi	0.01 %	2 %	
	Ca	0.01 %	50 %	
	Cd	0.001 %	2 %	
	Co	0.001 %	2 %	
	Cr	0.001 %	5 %	
	Cu	0.001 %	10 %	
	Fe	0.01 %	60 %	
	K	0.01 %	40 %	
	Mg	0.01 %	40 %	
	Mn	0.01 %	20 %	
	Mo	0.001 %	5 %	
	Na	0.01 %	25 %	
	Ni	0.001 %	10 %	
	P	0.01 %	25 %	
	Pb	0.02 %	10 %	
	S	0.05 %	30 %	
	Sb	0.01 %	1 %	
	Sr	0.01 %	1 %	
	W	0.01 %	1 %	
	Zn	0.01 %	40 %	
<b>MA370-X</b>	<b>Multi -acid ICP-ES, any 1 element</b>			<b>\$17.70</b>

**Requires at least 1 g per sample.**

Digestion is partial for some Cr and Ba minerals and oxides of Al, Fe, Hf, Mn, Sn, Ta, Zr and REEs. Volatilization during fuming may result in loss of As, S, Se and Sb.

## ORE & HIGH GRADE ANALYSIS

### PHOSPHORIC ACID ICP-ES

Phosphoric acid digestion for select elements.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
KP300	Phosphoric Acid, ICP-ES, 5 elements			\$20.70
	Mo	0.001 %	40 %	
	Nb	0.001 %	40 %	
	Ta	0.001 %	60 %	
	U	0.001 %	60 %	
	W	0.005 %	40 %	
KP300-X	Phosphoric Acid, ICP-ES, any 1 element			\$16.30
Requires at least 2 g per sample.				

**PEROXIDE FUSION ICP-ES** - Sodium peroxide fusion for refractory mineral ores. This process provides complete dissolution of most minerals including silicates. Volatile elements are lost at the high fusion temperatures.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
PF370	Peroxide Fusion ICP-ES, 17 elements			\$45.60
	Al	0.01 %	50 %	
	As	0.01 %	10 %	
	Ca	0.05 %	50 %	
	Co	0.002 %	30 %	
	Cr	0.01 %	30 %	
	Cu	0.005 %	30 %	
	Fe	0.05 %	70 %	
	K	0.01 %	30 %	
	Li	0.001 %	50 %	
	Mg	0.01 %	30 %	
	Mn	0.01 %	70 %	
	Ni	0.005 %	30 %	
	Pb	0.03 %	30 %	
	S	0.01 %	60 %	
	Sn	0.005 %	50 %	
	Ti	0.01 %	30 %	
	Zn	0.01 %	30 %	
PF370-X	Peroxide Fusion ICP-ES, any 1 element			\$21.20
Requires at least 1 g per sample.				





## ORE & HIGH GRADE ANALYSIS

### MERCURY

CODE	DESCRIPTION	DETECTION LIMIT	UPPER LIMIT	CAD
AQ200-Hg	Hg – ICP-MS	0.01 ppm	50 ppm	\$13.80
CV400	Trace Hg – CVAA	0.01 ppm	100 ppm	\$10.90

### WATER AND GENERAL CHEMISTRY

CODE	DESCRIPTION	DETECTION LIMIT	UPPER LIMIT	CAD
GC002	pH and conductivity on solids			\$19.65
GC002-COND	Conductivity of solids	3 µS/cm		\$14.70
GC002-pH	pH of solids	0.1 units		\$11.65
GC901	Moisture (105°C)			\$15.00
GC902	Lattice water			\$31.60
TG001	LOI	0.1%	100 %	\$10.70

### OTHER TRACE AND ORE GRADE ANALYSES

CODE	DESCRIPTION	DETECTION LIMIT	UPPER LIMIT	CAD
BR405	Select elements by HBr digestion, AAS Additional Element	Please call to discuss		\$31.50 + \$5.25
GC204	Ge or Ga by ICP-MS Second element	1 ppm	2000 ppm	\$24.80 + \$4.50
GC304	Ge or Ga by ICP-ES Second element	0.01 %	100 %	\$20.35 + \$4.55
GC320	Ba by Na <sub>2</sub> CO <sub>3</sub> /K <sub>2</sub> CO <sub>3</sub> fusion, ICP-ES	0.01 %	30 %	\$31.90
GC410	NiS	0.001 %	100 %	\$31.60
GC519	SiO <sub>2</sub> gravimetric	0.1 %	100 %	\$30.40
GC520	Ba by Na <sub>2</sub> CO <sub>3</sub> /K <sub>2</sub> CO <sub>3</sub> fusion, gravity	0.1 %	100 %	\$31.90
GC806	FeO Titration	0.2 %	100 %	\$27.70
GC816	Zn Titration	1.00 %	100 %	\$34.65
GC817	Pb Titration	2.00 %	100 %	\$38.85
GC818	Fe Titration	1.00 %	100 %	\$40.70
GC819	Mn Titration	1.00 %	100 %	\$37.05
GC820	Cu Titration	1.00 %	100 %	\$54.80
GC840	F – Trace Level	10 ppm	1000 ppm	\$21.75
GC841	F – Ore Grade Surcharge samples > 15%	0.01 % 10 %	15% 50 %	\$22.84 \$20.95
GC923	Pb or Zn Oxide Additional element	0.01 %	10 %	\$28.95 + \$4.50
PF100-B	B	3 ppm	2000 ppm	\$21.05

### OTHER CHARGES

CODE	DESCRIPTION	CAD
EN004	Environmental fee charge	\$0.95



**BUREAU  
VERITAS**

## EXPLORATION GEOCHEMISTRY

**BUREAU VERITAS LABORATORIES ARE RENOWNED FOR THE USE OF CUTTING EDGE TECHNOLOGIES TO OBTAIN THE LOW LEVELS OF DETECTION NEEDED TO MEET EXPLORATION GEOCHEMICAL REQUIREMENTS.**

Methods in this section are designed for nonmineralized to weakly mineralized material. They have been optimized to provide trace to ultra-trace detection limits and maximum anomaly to background contrast. Modified aqua regia (1:1:1 HNO<sub>3</sub>:HCl:H<sub>2</sub>O) packages target labile elements in soil, to more aggressive multi-acid digestions that are near total for almost all matrices. For projects with a gold focus, larger sample sizes are available to provide the most representative sample possible and mitigate nugget effects. This section also includes methods designed specifically for other media including biogeochemical exploration and natural water.

## EXPLORATION GEOCHEMISTRY

**Aqua Regia** - Using a modified aqua regia digestion (1:1:1 HNO<sub>3</sub>:HCl:H<sub>2</sub>O), a partial digest can provide valuable information regarding mobile and easily soluble species, such as sulphides. Economically priced ICP-ES (AQ300) or ICP-ES/MS (AQ200) analyses are designed to complement your exploration project. Sample splits of 0.5 g, 15 g or 30 g are leached in modified aqua regia. Select a larger split size for more representative Au analysis. Refractory and graphitic samples can limit Au solubility.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>AQ300</b>	<b>Aqua Regia ICP-ES, 34 elements, 0.5 g</b>			<b>\$11.25</b>
	Ag	0.3 ppm	100 ppm	
	Al	0.01 %	10 %	
	As	2 ppm	10000 ppm	
	B	20 ppm	2000 ppm	
	Ba	1 ppm	10000 ppm	
	Bi	3 ppm	2000 ppm	
	Ca	0.01 %	40 %	
	Cd	0.5 ppm	2000 ppm	
	Co	1 ppm	2000 ppm	
	Cr	1 ppm	10000 ppm	
	Cu	1 ppm	10000 ppm	
	Fe	0.01 %	40 %	
	Ga	5 ppm	1000 ppm	
	Hg	1 ppm	50 ppm	
	K	0.01 %	10 %	
	La	1 ppm	10000 ppm	
	Mg	0.01 %	30 %	
	Mn	2 ppm	10000 ppm	
	Mo	1 ppm	2000 ppm	
	Na	0.01 %	5 %	
	Ni	1 ppm	10000 ppm	
	P	0.001 %	5 %	
	Pb	3 ppm	10000 ppm	
	S	0.05 %	10 %	
	Sb	3 ppm	2000 ppm	
	Sc	5 ppm	100 ppm	
	Sr	1 ppm	2000 ppm	
	Th	2 ppm	2000 ppm	
	Ti	0.001 %	5 %	
	Tl	5 ppm	1000 ppm	
	U	8 ppm	2000 ppm	
	V	1 ppm	10000 ppm	
	W	2 ppm	100 ppm	
	Zn	1 ppm	10000 ppm	

Aqua Regia digestion is considered a partial digestion. Solubility of some elements will be limited by mineral species present.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>AQ200</b>	<b>Aqua Regia ICP-ES/MS, 37 elements, 0.5 g</b>			<b>\$18.75</b>
<b>AQ201</b>	<b>Aqua Regia ICP-ES/MS, 37 elements, 15 g</b>			<b>\$23.75</b>
<b>AQ202</b>	<b>Aqua Regia ICP-ES/MS, 37 elements, 30 g</b>			<b>\$28.70</b>
	Ag	0.1 ppm	100 ppm	
	Al	0.01 %	10 %	
	As	0.5 ppm	10000 ppm	
	Au	0.5 ppb	100000 ppb	
	B *	20 ppm	2000 ppm	
	Ba	1 ppm	10000 ppm	
	Bi	0.1 ppm	2000 ppm	
	Ca	0.01 %	40 %	
	Cd	0.1 ppm	2000 ppm	
	Co	0.1 ppm	2000 ppm	
	Cr	1 ppm	10000 ppm	
	Cu	0.1 ppm	10000 ppm	
	Fe	0.01 %	40 %	
	Ga	1 ppm	1000 ppm	
	Hg	0.01 ppm	50 ppm	
	K	0.01 %	10 %	
	La	1 ppm	10000 ppm	
	Mg	0.01 %	30 %	
	Mn	1 ppm	10000 ppm	
	Mo	0.1 ppm	2000 ppm	
	Na	0.001 %	5 %	
	Ni	0.1 ppm	10000 ppm	
	P	0.001 %	5 %	
	Pb	0.1 ppm	10000 ppm	
	S	0.05 %	10 %	
	Sb	0.1 ppm	2000 ppm	
	Sc	0.1 ppm	100 ppm	
	Se	0.5 ppm	100 ppm	
	Sr	1 ppm	2000 ppm	
	Te	0.2 ppm	1000 ppm	
	Th	0.1 ppm	2000 ppm	
	Ti	0.001 %	5 %	
	Tl	0.1 ppm	1000 ppm	
	U	0.1 ppm	2000 ppm	
	V**	1 ppm	10000 ppm	
	W	0.1 ppm	100 ppm	
	Zn	1 ppm	10000 ppm	

\*Detection limit = 1 ppm for 15/30 g analysis

\*\*Soils = 2 ppm



## EXPLORATION GEOCHEMISTRY

**Ultra-trace by ICP-MS** - ICP-MS analysis of a 0.5, 15 or 30 g sample after modified aqua regia digestion (1:1:1 HNO<sub>3</sub>:HCl:H<sub>2</sub>O) for low to ultra-low determination on soils, sediments and lean rocks. Larger splits (15 or 30 g) give a more representative analysis of elements subject to nugget effect (e.g., Au). Gold solubility can be limited in refractory and graphitic samples. The lead isotope method adds <sup>204</sup>Pb, <sup>206</sup>Pb, <sup>207</sup>Pb, <sup>208</sup>Pb. This data is suitable for geochemical exploration of U and other commodities where gross differences in non-radiogenic to radiogenic Pb ratios are of benefit.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
AQ250	Aqua Regia ICP-ES/MS, 37 elements, 0.5 g			\$23.15
AQ251	Aqua Regia ICP-ES/MS, 37 elements, 15 g			\$28.15
AQ252	Aqua Regia ICP-ES/MS, 37 elements, 30 g			\$33.15
	Ag	2 ppb	100000 ppb	
	Al	0.01 %	10 %	
	As	0.1 ppm	10000 ppm	
	Au	0.2 ppb	100000 ppb	
	B *	20 ppm	2000 ppm	
	Ba	0.5 ppm	10000 ppm	
	Bi	0.02 ppm	2000 ppm	
	Ca	0.01 %	40 %	
	Cd	0.01 ppm	2000 ppm	
	Co	0.1 ppm	2000 ppm	
	Cr	0.5 ppm	10000 ppm	
	Cu	0.01 ppm	10000 ppm	
	Fe	0.01 %	40 %	
	Ga	0.1 ppm	1000 ppm	
	Hg	5 ppb	50000 ppm	
	K	0.01 %	10 %	
	La	0.5 ppm	10000 ppm	
	Mg	0.01 %	30 %	
	Mn	1 ppm	10000 ppm	
	Mo	0.01 ppm	2000 ppm	
	Na	0.001 %	5 %	
	Ni	0.1 ppm	10000 ppm	
	P	0.001 %	5 %	
	Pb	0.01 ppm	10000 ppm	
	S	0.02 %	10 %	
	Sb	0.02 ppm	2000 ppm	
	Sc	0.1 ppm	100 ppm	
	Se	0.1 ppm	100 ppm	
	Sr	0.5 ppm	2000 ppm	
	Te	0.02 ppm	1000 ppm	
	Th	0.1 ppm	2000 ppm	
	Ti	0.001 %	5 %	
	Tl	0.02 ppm	1000 ppm	
	U	0.1 ppm	2000 ppm	
	V	1 ppm	10000 ppm	
	W	0.1 ppm	100 ppm	
	Zn	0.1 ppm	10000 ppm	

AQ250 Pt Pd, Add on \$2.55

\*Detection limit = 1 ppm for 15/30 g analysis

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
AQ250-EXT	Extended Pkg, 53 elements, 0.5 g			\$27.10
AQ251-EXT	Extended Pkg, 53 elements, 15 g			\$32.10
AQ252-EXT	Extended Pkg, 53 elements, 30 g			\$37.10
	Be	0.1 ppm	1000 ppm	
	Ce	0.1 ppm	2000 ppm	
	Cs	0.02 ppm	2000 ppm	
	Ge	0.1 ppm	100 ppm	
	Hf	0.02 ppm	1000 ppm	
	Ln	0.02 ppm	1000 ppm	
	Li	0.1 ppm	2000 ppm	
	Nb	0.02 ppm	2000 ppm	
	Pd	10 ppb	100000 ppb	
	Pt	2 ppb	100000 ppb	
	Rb	0.1 ppm	2000 ppm	
	Re	1 ppb	100000 ppb	
	Sn	0.1 ppm	100 ppm	
	Ta	0.05 ppm	2000 ppm	
	Y	0.01 ppm	2000 ppm	
	Zr	0.1 ppm	2000 ppm	

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
+ REE	Rare Earth, Add on			\$7.60
	Dy	0.02 ppm	2000 ppm	
	Er	0.02 ppm	2000 ppm	
	Eu	0.02 ppm	2000 ppm	
	Gd	0.02 ppm	2000 ppm	
	Ho	0.02 ppm	2000 ppm	
	Lu	0.02 ppm	2000 ppm	
	Nd	0.02 ppm	2000 ppm	
	Pr	0.02 ppm	2000 ppm	
	Sm	0.02 ppm	2000 ppm	
	Tb	0.02 ppm	2000 ppm	
	Tm	0.02 ppm	2000 ppm	
	Yb	0.02 ppm	2000 ppm	

+ ISO Lead Isotope, Add on \$15.65

## EXPLORATION GEOCHEMISTRY

**Multi-Acid** - Multi-acid digestion packages are capable of dissolving most minerals. We offer a choice of ICP-ES (MA300), ICP-ES/MS (MA200) or Ultra-trace ICP-ES/MS (MA250) analysis to give near total values for most elements. A 0.25 g split is heated in HNO<sub>3</sub>, HClO<sub>4</sub> and HF to fuming and taken to dryness. The residue is dissolved in HCl.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>MA300</b>	<b>Multi-Acid ICP-ES, 35 elements, 0.25 g</b>			<b>\$17.30</b>
	Ag	0.5 ppm	200 ppm	
	Al	0.01 %	20 %	
	As	5 ppm	10000 ppm	
	Ba	1 ppm	10000 ppm	
	Be	1 ppm	1000 ppm	
	Bi	5 ppm	4000 ppm	
	Ca	0.01 %	40 %	
	Cd	0.4 ppm	4000 ppm	
	Co	2 ppm	4000 ppm	
	Cr	2 ppm	10000 ppm	
	Cu	2 ppm	10000 ppm	
	Fe	0.01 %	60 %	
	K	0.01 %	10 %	
	La	2 ppm	2000 ppm	
	Mg	0.01 %	30 %	
	Mn	5 ppm	10000 ppm	
	Mo	2 ppm	4000 ppm	
	Na	0.01 %	10 %	
	Nb	2 ppm	2000 ppm	
	Ni	2 ppm	10000 ppm	
	P	0.002 %	5 %	
	Pb	5 ppm	10000 ppm	
	S	0.1 %	10 %	
	Sb	5 ppm	4000 ppm	
	Sc	1 ppm	200 ppm	
	Sn	2 ppm	2000 ppm	
	Sr	2 ppm	10000 ppm	
	Th	2 ppm	4000 ppm	
	Ti	0.01 %	10 %	
	U	20 ppm	4000 ppm	
	V	2 ppm	10000 ppm	
	W	4 ppm	200 ppm	
	Y	2 ppm	2000 ppm	
	Zn	2 ppm	10000 ppm	
	Zr	2 ppm	2000 ppm	

<b>AQ200-Hg</b>	<b>Aqua Regia ICP-ES/MS, add-on</b>			<b>\$13.80</b>
	Hg	0.01 ppm	50 ppm	

Digestion is partial for some Cr and Ba minerals and oxides of Al, Fe, Hf, Mn, Sn, Ta, Zr and REEs. Volatilization during fuming may result in loss of As, S, Se and Sb.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>MA200</b>	<b>Multi-Acid ICP-ES, 45 elements, 0.25 g</b>			<b>\$25.50</b>
	Ag	0.1 ppm	200 ppm	
	Al	0.01 %	20 %	
	As	1 ppm	10000 ppm	
	Ba	1 ppm	10000 ppm	
	Be	1 ppm	1000 ppm	
	Bi	0.1 ppm	4000 ppm	
	Ca	0.01 %	40 %	
	Cd	0.1 ppm	4000 ppm	
	Ce	1 ppm	40 %	
	Co	0.2 ppm	4000 ppm	
	Cr	1 ppm	10000 ppm	
	Cu	0.1 ppm	10000 ppm	
	Fe	0.01 %	60 %	
	Hf	0.1 ppm	1000 ppm	
	Ln	0.05 ppm	1000 ppm	
	K	0.01 %	10 %	
	La	0.1 ppm	2000 ppm	
	Li	0.1 ppm	2000 ppm	
	Mg	0.01 %	30 %	
	Mn	1 ppm	10000 ppm	
	Mo	0.1 ppm	4000 ppm	
	Na	0.001 %	10 %	
	Nb	0.1 ppm	2000 ppm	
	Ni	0.1 ppm	10000 ppm	
	P	0.001 %	5 %	
	Pb	0.1 ppm	10000 ppm	
	Rb	0.1 ppm	2000 ppm	
	Re	0.005 ppm	100 ppm	
	S	0.1 %	10 %	
	Sb	0.1 ppm	4000 ppm	
	Sc	1 ppm	200 ppm	
	Se	1 ppm	1000 ppm	
	Sn	0.1 ppm	2000 ppm	
	Sr	1 ppm	10000 ppm	
	Ta	0.1 ppm	2000 ppm	
	Te	0.5 ppm	1000 ppm	
	Th	0.1 ppm	4000 ppm	
	Ti	0.001 %	10 %	
	Tl	0.5 ppm	10000 ppm	
	U	0.1 ppm	4000 ppm	
	V	4 ppm	10000 ppm	
	W	0.1 ppm	200 ppm	
	Y	0.1 ppm	2000 ppm	
	Zn	1 ppm	10000 ppm	
	Zr	0.1 ppm	2000 ppm	

<b>AQ200-Hg</b>	<b>Aqua Regia ICP-ES/MS, add-on</b>			<b>\$13.80</b>
	Hg	0.01 ppm	50 ppm	

Digestion is partial for some Cr and Ba minerals and oxides of Al, Fe, Hf, Mn, Sn, Ta, Zr and REEs. Volatilization during fuming may result in loss of As, S, Se and Sb.

# EXPLORATION GEOCHEMISTRY

## ULTRA-TRACE BY ICP-ES/MS

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
MA250	Ultra-trace ICP-ES/MS, 59 elements, 0.25 g			\$34.15
	Ag	20 ppb	200000 ppb	
	Al	0.01 %	20 %	
	As	0.2 ppm	10000 ppm	
	Ba	1 ppm	10000 ppm	
	Be	1 ppm	1000 ppm	
	Bi	0.04 ppm	4000 ppm	
	Ca	0.01 %	40 %	
	Cd	0.02 ppm	4000 ppm	
	Ce	0.02 ppm	2000 ppm	
	Co	0.2 ppm	4000 ppm	
	Cr	1 ppm	10000 ppm	
	Cs	0.1 ppm	2000 ppm	
	Cu	0.1 ppm	10000 ppm	
	Dy	0.1 ppm	2000 ppm	
	Er	0.1 ppm	2000 ppm	
	Eu	0.1 ppm	2000 ppm	
	Fe	0.01 %	60 %	
	Ga	0.02 ppm	100 ppm	
	Gd	0.1 ppm	2000 ppm	
	Hf	0.02 ppm	1000 ppm	
	Ho	0.1 ppm	2000 ppm	
	In	0.01 ppm	1000 ppm	
	K	0.01 %	10 %	
	La	0.1 ppm	2000 ppm	
	Li	0.1 ppm	2000 ppm	
	Lu	0.1 ppm	2000 ppm	
	Mg	0.01 %	30 %	
	Mn	1 ppm	10000 ppm	
	Mo	0.05 ppm	4000 ppm	
	Na	0.001 %	10 %	
	Nb	0.04 ppm	2000 ppm	
	Nd	0.1 ppm	2000 ppm	
	Ni	0.1 ppm	10000 ppm	
	P	0.001 %	5 %	
	Pb	0.02 ppm	10000 ppm	
	Pr	0.1 ppm	2000 ppm	
	Rb	0.1 ppm	2000 ppm	
	Re	0.002 ppm	100 ppm	
	S	0.04 %	10 %	
	Sb	0.02 ppm	4000 ppm	
	Sc	0.1 ppm	200 ppm	
	Se	0.3 ppm	1000 ppm	
	Sm	0.1 ppm	2000 ppm	
	Sn	0.1 ppm	2000 ppm	
	Sr	1 ppm	10000 ppm	
	Ta	0.1 ppm	2000 ppm	
	Tb	0.1 ppm	2000 ppm	
	Te	0.05 ppm	1000 ppm	
	Th	0.1 ppm	4000 ppm	
	Ti	0.001 %	10 %	
	Tl	0.05 ppm	10000 ppm	
	Tm	0.1 ppm	2000 ppm	
	U	0.1 ppm	4000 ppm	
	V	2 ppm	10000 ppm	
	W	0.1 ppm	200 ppm	
	Y	0.1 ppm	2000 ppm	
	Yb	0.1 ppm	2000 ppm	
	Zn	0.2 ppm	10000 ppm	
	Zr	0.2 ppm	2000 ppm	
AQ200-Hg	Aqua Regia ICP-ES/MS, Add-on			\$13.80
	Hg	0.01 ppm	50 ppm	

Digestion is partial for some Cr and Ba minerals and oxides of Al, Fe, Hf, Mn, Sn, Ta, Zr and REEs. Volatilization during fuming may result in loss of As, S, Se and Sb.



## EXPLORATION GEOCHEMISTRY

**Low Grade Ore Analysis** - The following multi-element assays provide an expanded range of analysis by combining the geochemical analysis MA200 and AQ200 with the upper limit precision of the assay packages MA370 and AQ370. AQ270 and MA270 combine both ICP-ES and ICP-MS analysis to extend the upper limits and provide a broader spectrum of elements. Intended use of this package is for exploration not resource calculations.

**AQUA REGIA ICP-ES/MS** - Same digestion as AQ370 but uses both ICPEs and ICP-MS to expand the detection limits and increase the number of elements analyzed.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>AQ270</b>	<b>Aqua Regia ICP-ES/MS, 34 elements</b>			<b>\$29.10</b>
	Ag	0.5 ppm	1000 ppm	
	Al	0.01 %	40 %	
	As	5 ppm	10000 ppm	
	Ba	5 ppm	5000 ppm	
	Bi	0.5 ppm	10000 ppm	
	Ca	0.01 %	40 %	
	Cd	0.5 ppm	10000 ppm	
	Co	0.5 ppm	10000 ppm	
	Cr	0.5 ppm	50000 ppm	
	Cu	0.5 ppm	100000 ppm	
	Fe	0.01 %	40 %	
	Ga	5 ppm	5000 ppm	
	Hg	0.5 ppm	10000 ppm	
	K	0.01 %	40 %	
	La	0.5 ppm	50000 ppm	
	Mg	0.01 %	40 %	
	Mn	5 ppm	200000 ppm	
	Mo	0.5 ppm	50000 ppm	
	Na	0.01 %	25 %	
	Ni	0.5 ppm	100000 ppm	
	P	0.001 %	25 %	
	Pb	0.5 ppm	40000 ppm	
	S	0.05 %	30 %	
	Sb	0.5 ppm	50000 ppm	
	Sc	0.5 ppm	500 ppm	
	Se	2 ppm	500 ppm	
	Sr	5 ppm	10000 ppm	
	Th	0.5 ppm	10000 ppm	
	Ti	0.001 %	10 %	
	Tl	0.5 ppm	5000 ppm	
	U	0.5 ppm	10000 ppm	
	V	10 ppm	50000 ppm	
	W	0.5 ppm	10000 ppm	
	Zn	5 ppm	200000 ppm	

Requires at least 2 g per sample.

**MULTI-ACID ICP-ES/MS** - Same digestion as MA370 but includes ICP-ES and ICP-MS analysis.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>MA270</b>	<b>Multi-acid ICP-ES/MS, 41 elements</b>			<b>\$35.40</b>
	Ag	0.5 ppm	1500 ppm	
	Al	0.01 %	40 %	
	As	5 ppm	100000 ppm	
	Ba	5 ppm	50000 ppm	
	Be	5 ppm	5000 ppm	
	Bi	0.5 ppm	20000 ppm	
	Ca	0.01 %	50 %	
	Cd	0.5 ppm	20000 ppm	
	Ce	5 ppm	10000 ppm	
	Co	1 ppm	20000 ppm	
	Cr	1 ppm	50000 ppm	
	Cu	0.5 ppm	100000 ppm	
	Fe	0.01 %	60 %	
	Hf	0.5 ppm	5000 ppm	
	K	0.01 %	40 %	
	La	0.5 ppm	10000 ppm	
	Li	0.5 ppm	10000 ppm	
	Mg	0.01 %	40 %	
	Mn	5 ppm	200000 ppm	
	Mo	0.5 ppm	50000 ppm	
	Na	0.01 %	25 %	
	Nb	0.5 ppm	10000 ppm	
	Ni	0.5 ppm	100000 ppm	
	P	0.01 %	25 %	
	Pb	0.5 ppm	100000 ppm	
	Rb	0.5 ppm	10000 ppm	
	S	0.05 %	30 %	
	Sb	0.5 ppm	10000 ppm	
	Sc	1 ppm	1000 ppm	
	Se	5 ppm	5000 ppm	
	Sn	0.5 ppm	10000 ppm	
	Sr	5 ppm	10000 ppm	
	Ta	0.5 ppm	2000 ppm	
	Th	0.5 ppm	20000 ppm	
	Ti	0.001 %	10 %	
	U	0.5 ppm	20000 ppm	
	V	10 ppm	50000 ppm	
	W	0.5 ppm	10000 ppm	
	Y	0.5 ppm	5000 ppm	
	Zn	5 ppm	400000 ppm	
	Zr	0.5 ppm	10000 ppm	

Digestion is partial for some Cr and Ba minerals and oxides of Al, Fe, Hf, Mn, Sn, Ta, Zr and REEs. Volatilization during fuming may result in loss of As, S, Se and Sb.

## EXPLORATION GEOCHEMISTRY

**Vegetation Analysis** - We offer two types of vegetation preparations depending on the elements of interest and application of the results. The first is an aqua regia digestion on the raw material. This method is best where volatile elements such as As, Se, and Hg are of interest. The second type of preparation involves the ashing of plant material followed by aqua regia digestion. Ashing is effectively a preconcentration step that allows for the detection of low level precious metals that would otherwise be below instrument detection.

**Preparation** - For dry plant material free of any soil. Importation permits may apply; contact the laboratory prior to shipment.

CODE	DESCRIPTION	CAD
DISPL	Dispose of pulps	\$0.20
SVRJT	Saving all or part of reject fraction	\$1.15
VA475	Ashing 50 g dry vegetation at 475°C	\$12.15
VGMAS	Dry and macerate vegetation, per 100 g	\$12.15
VGWSH	Wash plant samples with demineralized water, dry at 60°C, per 100 g	\$3.50
WGHT	Weigh samples	\$0.80

**Plant Material Analysis** - Analysis of vegetation samples using a 1g or 5g split digested in HNO<sub>3</sub> then aqua regia and analyzed by ICP-MS for ultra low detection limits. Washing with demineralized water is recommended if samples are coated with inorganic material. (See VGWSH above).

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD		
VG101	Dry Vegetation ICP-MS, 37 elements, 1 g			\$ 29.45		
VG105	Dry Vegetation ICP-MS, 37 elements, 5 g			\$ 33.30		
	Ag	2 ppb	100000 ppb	Mo	0.01 ppm	2000 ppm
	Al	0.01 %	10 %	Na	0.01 %	5 %
	As	0.1 ppm	10000 ppm	Ni	0.1 ppm	10000 ppm
	Au	0.2 ppb	100000 ppb	P	0.001 %	5 %
	B	1 ppm	2000 ppm	Pb	0.01 ppm	10000 ppm
	Ba	0.1 ppm	10000 ppm	S	0.05 %	10 %
	Bi	0.02 ppm	2000 ppm	Sb	0.02 ppm	2000 ppm
	Ca	0.01 %	40 %	Sc	0.1 ppm	100 ppm
	Cd	0.01 ppm	2000 ppm	Se	0.1 ppm	100 ppm
	Co	0.01 ppm	2000 ppm	Sr	0.5 ppm	2000 ppm
	Cr	0.1 ppm	10000 ppm	Te	0.02 ppm	10000 ppm
	Cu	0.01 ppm	10000 ppm	Th	0.1 ppm	2000 ppm
	Fe	0.001 %	40 %	Ti	10 ppm	50000 ppm
	Ga	0.1 ppm	1000 ppm	Tl	0.02 ppm	10000 ppm
	Hg	1 ppb	50000ppb	U	0.01 ppm	2000 ppm
	K	0.01 %	10 %	V	2 ppm	10000 ppm
	La	0.01 ppm	10000 ppm	W	0.1 ppm	100 ppm
	Mg	0.001 %	30 %	Zn	0.1 ppm	10000 ppm
	Mn	1 ppm	10000 ppm			
+ REE	Rare Earth, add-on					\$7.60
+ PGM	Pt Pd, add-on					\$2.55
+ ISO	Lead Isotope, add-on					\$15.65
VG104	Ash Ultra-trace ICP-MS, 36 elements, 0.5 g (same elements & detection limits as AQ250 excluding Hg , p.23)					\$23.15
VG104-EXT	Ash Extended suite, 52 elements, 0.5 g					\$27.10

## EXPLORATION GEOCHEMISTRY

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>VG101-EXT</b>	Dry Extended suite, 53 elements, 1 g			\$33.40
<b>VG105-EXT</b>	Dry Extended suite, 53 elements, 5 g			\$37.25
	<b>Be</b>	0.1 ppm	1000 ppm	
	<b>Ce</b>	0.1 ppm	2000 ppm	
	<b>Cs</b>	0.02 ppm	2000 ppm	
	<b>Ge</b>	0.01 ppm	100 ppm	
	<b>Hf</b>	0.001 ppm	1000 ppm	
	<b>Ln</b>	0.02 ppm	1000 ppm	
	<b>Li</b>	0.01 ppm	2000 ppm	
	<b>Nb</b>	0.01 ppm	2000 ppm	
	<b>Pd</b>	2 ppb	100000 ppb	
	<b>Pt</b>	1 ppb	100000 ppb	
	<b>Rb</b>	0.1 ppm	2000 ppm	
	<b>Re</b>	1 ppb	10000 ppm	
	<b>Sn</b>	0.02 ppm	100 ppm	
	<b>Ta</b>	0.001 ppm	2000 ppm	
	<b>Y</b>	0.001 ppm	2000 ppm	
	<b>Zr</b>	0.01 ppm	2000 ppm	
<b>+ ISO</b>	Lead Isotope, Add on			\$14.90

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>+ REE</b>	Rare Earth elements			\$7.60
	<b>Dy</b>	0.02 ppm	2000 ppm	
	<b>Er</b>	0.02 ppm	2000 ppm	
	<b>Eu</b>	0.02 ppm	2000 ppm	
	<b>Gd</b>	0.02 ppm	2000 ppm	
	<b>Ho</b>	0.02 ppm	2000 ppm	
	<b>Lu</b>	0.02 ppm	2000 ppm	
	<b>Nd</b>	0.02 ppm	2000 ppm	
	<b>Pr</b>	0.02 ppm	2000 ppm	
	<b>Sm</b>	0.02 ppm	2000 ppm	
	<b>Tb</b>	0.02 ppm	2000 ppm	
	<b>Tm</b>	0.02 ppm	2000 ppm	
	<b>Yb</b>	0.02 ppm	2000 ppm	



## EXPLORATION GEOCHEMISTRY

**Generative Exploration Package** - This package has been designed to provide a suite of elements common in rocks associated with hydrothermal systems. It represents excellent value for applications where only ore forming elements are of interest.

CODE	ELEMENT	CAD
GENX10	Suite of elements common in rocks associated with hydrothermal systems	\$29.05
	<b>Au</b> 0.005 - 10 ppm	
	<b>Ag</b> 0.3 - 100 ppm	
	<b>As</b> 2 - 10,000 ppm	
	<b>Bi</b> 3 - 2,000 ppm	
	<b>Cu</b> 1 - 10,000 ppm	
	<b>Pb</b> 3 - 10,000 ppm	
	<b>Hg</b> 0.01 - 100 ppm	
	<b>Mo</b> 1 - 2,000 ppm	
	<b>Sb</b> 3 - 2,000 ppm	
	<b>Zn</b> 1 - 10,000 ppm	

Au determined by FA430 (30 g Fire Assay/AAS finish) Hg determined by Cold Vapour/AA  
All other elements determined by AQ300 Digest with ICP analysis

**This package combines both of our ultra-trace packages**

CODE	DESCRIPTION	CAD
GEO05	MA250 + AQ250 (7 elements: As, Au, Hg, Sb, Se, Te, Tl)	\$47.70
+ Au	Fire Assay (FA430: 30 g Fire Assay/AAS finish), add-on	\$16.35

**Selectives Leaches** - Selective or sequential extractions can target elements held in a specific soil phase or a range of phases thus allowing better interpretation of ion mobility and geochemical processes. Used sequentially, the leaches can determine whether elements in soils are present as salts, adsorbed to clay minerals, adsorbed/complexed with organics, or associated with amorphous Mn and Fe hydroxides.

CODE	DESCRIPTION	CAD
	Separate leach, per leach	\$35.60
	Sequential leach, per leach	\$45.00
	Setup, per leach on submissions of <35 samples	\$375.40
	Report pH	+ \$10.70
LH101	Demineralized water soluble components	
LH102	1 M Ammonium acetate - exchangeable cations adsorbed by clay and elements co-precipitated with carbonates	
LH103	0.1 M Sodium pyrophosphate - elements adsorbed by organic matter (humic and fulvic compounds)	
LH104	0.1 M Hydroxylamine - elements adsorbed by amorphous Mn hydroxide, often the most reactive soil phase for scavenging mobile elements	
LH105	0.25 M Hydroxylamine - elements adsorbed by amorphous Fe hydroxide and more crystalline Mn hydroxide	
LH107	Ammonium nitrate leach estimates metal bioavailability and involves the extraction of weakly bound mobile base metals, alkali, alkaline earth, and Al ions. Can also be used for estimation of cation-exchange capacity (separate leach only).	

### Other Charges

CODE	DESCRIPTION	CAD
EN004	Environmental fee charge	\$0.95

## EXPLORATION GEOCHEMISTRY

**Analysis of Natural Waters ICP-MS** - Surface and groundwater surveys are an effective means for exploration of remote and blind ore deposits. Method SO200 (analysis by ICP-MS) provides the low detection limits needed to define background and anomalous levels of cations in natural water. For this analysis, all water samples must have less than 0.1% total dissolved solids (TDS). This method is not suitable for brines or processed solutions. Water samples with greater than 0.1% total dissolved solids will report a reduced element suite with elevated detection limits.

Analysis of water geochemical parameters, including pH, electrical conductivity, alkalinity, and anions, provides the necessary parameters for complete characterization of water samples. Complete water characterization allows for the determination of not only the type of water (i.e., CaSO<sub>4</sub> or NaCl), but how the type of water relates to ore deposit pathfinder elements. This package is not suitable for environmental surveys.

CODE	ELEMENT	DETECTION LIMIT	ELEMENT	DETECTION LIMIT	ELEMENT	DETECTION LIMIT	CAD
SO200*	Full Suite - Cations, 50 ml						\$ 36.30
	Ag	0.05 ppm	Gf	0.02 ppb	S	1 ppm	
	Al	1 ppb	Hg	0.1 ppb	Sb	0.05 ppb	
	As	0.5 ppb	Ho	0.01 ppb	Sc	1 ppb	
	Au	0.05 ppb	Ln	0.01 ppb	Se	0.5 ppb	
	B	5 ppb	K	0.05 ppm	Si	40 ppb	
	Ba	0.05 ppb	La	0.01 ppb	Sm	0.02 ppb	
	Be	0.05 ppb	Li	0.1 ppb	Sn	0.05 ppb	
	Bi	0.05 ppb	Lu	0.01 ppb	Sr	0.01 ppb	
	Br	5 ppb	Mg	0.05 ppm	Ta	0.02 ppb	
	Ca	0.05 ppm	Mn	0.05 ppb	Tb	0.01 ppb	
	Cd	0.05 ppm	Mo	0.1 ppb	Te	0.05 ppb	
	Ce	0.01 ppb	Na	0.05 ppm	Th	0.05 ppb	
	Cl	1 ppm	Nb	0.01 ppb	Ti	10 ppb	
	Co	0.02 ppb	Nd	0.01 ppb	Tl	0.01 ppb	
	Cr	0.5 ppb	Ni	0.2 ppb	Tm	0.01 ppb	
	Cs	0.01 ppb	P	10 ppb	U	0.02 ppb	
	Cu	0.1 ppb	Pb	0.1 ppb	V	0.2 ppb	
	Dy	0.01 ppb	Pd	0.2 ppb	W	0.02 ppb	
	Er	0.01 ppb	Pr	0.01 ppb	Y	0.01 ppb	
	Eu	0.01 ppb	Pt	0.01 ppb	Yb	0.01 ppb	
	Fe	10 ppb	Rb	0.01 ppb	Zn	0.5 ppb	
	Ga	0.05 ppb	Re	0.01 ppb	Zr	0.02 ppb	
	Gd	0.01 ppb	Rh	0.01 ppb			
	Ge	0.05 ppb	Ru	0.05 ppb			



CONTACT US

FOR A QUOTE

CODE	ELEMENT	DETECTION LIMIT	CODE	ELEMENT	DETECTION LIMIT	BRINE ANALYSIS
SO001*	Per element , 100 ml*		SO002*	pH and EC, 100 ml*		CODE
	Cl	0.5 mg/L				ICPTV-W
	SO <sub>4</sub>	0.5 mg/L				ICP-ES/MS analysis for high TDS water samples.
	Br	0.4 mg/L				Analysis is also applicable for Li-brines.
	NO <sub>2</sub>	0.01 mg/L	CODE	Full Suite CaCO <sub>3</sub> , HCO <sub>3</sub> , OH, 100 ml*		
	NO <sub>3</sub>	0.01 mg/L	SO003*	Alkalinity	0.5 mg/L	
	F	0.01 mg/L	*Samples for SO200, SO001, SO002 and SO003 must be submitted in separate bottles and require at least 50 ml per sample.			



**BUREAU  
VERITAS**

# LITHOGEOCHEMISTRY

**LITHOGEOCHEMICAL METHODS EMPLOY FUSION TECHNIQUES TO COMPLETELY DIGEST MOST REFRACTORY MATRICES. THESE METHODS ACCOUNT FOR STRUCTURAL WATER AND ARE THE ONLY MULTI-ELEMENT METHODS THAT PROVIDE QUANTITATIVE DETERMINATIONS FOR SILICA.**

The determinations from these methods are the most suitable for constructing rock classification diagrams, molar element ratios and alteration indices. Determination by ICP-ES, ICP-MS, XRF, and laser ablation options are available to suit almost all elements, concentration ranges, and professional preferences.



# LITHOGEOCHEMISTRY

## WHOLE ROCK MAJOR AND MINOR ELEMENTS BY ICP-ES

Lithium borate fusion, a highly aggressive dissolution, is effective for most refractory and resistive mineral phases. When coupled with ICP-ES/MS or XRF analysis, the methods provide excellent determination of the total element content.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
LF300	Standard suite of major oxides			\$32.50
	SiO <sub>2</sub>	0.01 %	100 %	
	Al <sub>2</sub> O <sub>3</sub>	0.01 %	100 %	
	Cr <sub>2</sub> O <sub>3</sub>	0.002 %	10 %	
	CaO	0.01 %	100 %	
	Fe <sub>2</sub> O <sub>3</sub>	0.04 %	100 %	
	K <sub>2</sub> O	0.01 %	100 %	
	MgO	0.01 %	100 %	
	MnO	0.01 %	30 %	
	Na <sub>2</sub> O	0.01 %	100 %	
	P <sub>2</sub> O <sub>5</sub>	0.01 %	100 %	
	TiO <sub>2</sub>	0.01 %	10 %	
	Ba	5 ppm	5 %	
	Nb	5 ppm	1,000 ppm	
	Ni	20 ppm	10,000 ppm	
	Sc	1 ppm	10,000 ppm	
	Sr	2 ppm	50,000 ppm	
	Y	3 ppm	50,000 ppm	
	Zr	5 ppm	50,000 ppm	
	LOI	0.1 %	100 %	
	Sum	0.01 %	100 %	
LF300-X	Any 1 element			\$23.15
LF300-EXT	Extended package			\$36.45
	Ce	30 ppm	50,000 ppm	
	Co	20 ppm	10,000 ppm	
	Cu	5 ppm	10,000 ppm	
	Zn	5 ppm	10,000 ppm	

## WHOLE ROCK MAJOR AND MINOR ELEMENTS WITH C & S

CODE		CAD
LF302	Major oxides ICP-ES, 20 elements Package including LF300 + TC000 (C & S)	\$48.95
LF302-EXT	Major oxides ICP-ES, Package including LF300-EXT + TC000 (C & S)	\$52.85

## TOTAL WHOLE ROCK CHARACTERIZATION

These packages include several methods that have been specifically selected to optimize the recovery of virtually all elements present in a geological sample.

LF200	Package including (LF100 + LF302)	\$74.55
LF202	Package including (LF100-EXT + LF302)	\$86.75
LF600*	Package including (LF100-EXT + XF700 + TC000)	\$94.25

Requires at least 5 g per sample. \* Requires at least 20 g per sample.

## TRACE ELEMENTS BY ICP-MS

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
LF100	Refractory and Rare Earth elements only			\$33.90
	Ba	1 ppm	50,000 ppm	
	Be	1 ppm	10,000 ppm	
	Ce	0.1 ppm	50,000 ppm	
	Co	0.2 ppm	10,000 ppm	
	Cs*	0.1 ppm	1,000 ppm	
	Dy	0.05 ppm	10,000 ppm	
	Er	0.03 ppm	10,000 ppm	
	Eu	0.02 ppm	10,000 ppm	
	Ga	0.5 ppm	10,000 ppm	
	Gd	0.05 ppm	10,000 ppm	
	Hf	0.1 ppm	10,000 ppm	
	Ho	0.02 ppm	10,000 ppm	
	La	0.1 ppm	50,000 ppm	
	Lu	0.01 ppm	10,000 ppm	
	Nb*	0.1 ppm	1,000 ppm	
	Nd	0.3 ppm	10,000 ppm	
	Pr	0.02 ppm	10,000 ppm	
	Rb*	0.1 ppm	1,000 ppm	
	Sm	0.05 ppm	10,000 ppm	
	Sn	1 ppm	10,000 ppm	
	Sr	0.5 ppm	50,000 ppm	
	Ta*	0.1 ppm	1,000 ppm	
	Tb	0.01 ppm	10,000 ppm	
	Th	0.2 ppm	10,000 ppm	
	Tm	0.01 ppm	10,000 ppm	
	U	0.1 ppm	10,000 ppm	
	V	8 ppm	10,000 ppm	
	W	0.5 ppm	10,000 ppm	
	Y	0.1 ppm	50,000 ppm	
	Yb	0.05 ppm	10,000 ppm	
	Zr	0.1 ppm	50,000 ppm	
LF100-X	Lithium borate fusion ICP-MS, any 1 element			\$23.15
LF100-EXT	Trace elements ICP-MS, 45 elements Package including (LF100 + AQ200)			\$47.40
	Ag	0.1 ppm	100 ppm	
	As	1 ppm	10,000 ppm	
	Au	0.5 ppm	100,000 ppm	
	Bi	0.5 ppm	2,000 ppm	
	Cd	0.1 ppm	2,000 ppm	
	Cu	0.1 ppm	10,000 ppm	
	Hg	0.01 ppm	50 ppm	
	Mo	0.1 ppm	2,000 ppm	
	Ni	0.1 ppm	10,000 ppm	
	Pb	0.1 ppm	10,000 ppm	
	Sb	0.1 ppm	2000 ppm	
	Se	0.5 ppm	100 ppm	
	Tl	0.1 ppm	1,000 ppm	
	Zn	5 ppm	10,000 ppm	

\* For higher upper limits on Ta, Nb, Cs, Rb - Request REEPKG Results for Co, Cu, Ni, Pb and Zn may not be quantitative by this method.

# LITHOGEOCHEMISTRY

## CARBON & SULPHUR ANALYSIS

CODE	DESCRIPTION	DETECTION LIMIT	UPPER LIMIT	CAD
TC000	Leco – C	0.02 %	50 %	\$21.85 + \$8.00
	Leco – S	0.02 %	20 %	
	Surcharge samples > 20% (S)	20 %	50 %	
TC000-C	Leco – Total C	0.02 %	100 %	\$18.60
TC005-GRA	Graphite C	0.02 %	20 %	\$39.45
TC006	Inorganic Carbon, (Direct CO <sub>2</sub> evolution Leco analysis)	0.08 %	100 %	\$21.85
TC005-ORG	Organic C (TC000-C, TC005-GRA, TC006)	0.02 %	100 %	\$39.60
TC000-S	Leco – Total S	0.02 %	20 %	\$18.60 + \$8.00
	Surcharge samples > 20% (S)	20 %	50 %	
TC008-SO4	Sulphate – Leco after ignition	0.05 %	100 %	\$27.30
TC008-S-	Sulphide – (TC000-S, TC008-SO4)	0.05 %	100 %	\$28.65
TC508	Sulphate – gravimetric	0.05 %	100 %	\$32.75
TC901	Elemental S	0.01 %	14 %	\$36.00

Requires at least 5 g per sample.

## XRF

X-ray fluorescence analysis on fused discs is an excellent method for the determination of whole rock major elements, as well as some minor elements. It is the preferred method for iron ore, bauxite, Nilaterites, and phosphate ores. Bureau Veritas also offers a specific XRF method for the determination of major elements, plus sub-percent to high-grade Cu, Pb, and Zn ore concentrations.

### WHOLE ROCK MAJOR OXIDES

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
XF700	Standard Package, 15 elements			\$38.20
	SiO <sub>2</sub>	0.01 %	100 %	
	Al <sub>2</sub> O <sub>3</sub>	0.01 %	100 %	
	Fe <sub>2</sub> O <sub>3</sub>	0.01 %	100 %	
	CaO	0.01 %	100 %	
	MgO	0.01 %	100 %	
	Na <sub>2</sub> O	0.01 %	15 %	
	K <sub>2</sub> O	0.01 %	15 %	
	MnO	0.01 %	50 %	
	TiO <sub>2</sub>	0.01 %	20 %	
	P <sub>2</sub> O <sub>5</sub>	0.01 %	40 %	
	Cr <sub>2</sub> O <sub>3</sub>	0.01 %	10 %	
	Ba	0.01 %	58.8 %	
	LOI	0.1 %	100 %	
	SO <sub>3</sub>	0.002 %	10 %	
	Sr	0.002 %	1.5 %	
XF702	Standard Package including TC000 (C & S)			\$47.85
	Requires at least 12 g per sample			

### BAUXITE

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
XF701	Bauxite Package, 17 elements			\$45.30
	SiO <sub>2</sub>	0.01 %	100 %	
	Al <sub>2</sub> O <sub>3</sub>	0.01 %	100 %	
	Fe <sub>2</sub> O <sub>3</sub>	0.01 %	100 %	
	CaO	0.01 %	50 %	
	MgO	0.01 %	40 %	
	Na <sub>2</sub> O	0.01 %	8.5 %	
	K <sub>2</sub> O	0.01 %	15 %	
	MnO	0.01 %	50 %	
	TiO <sub>2</sub>	0.01 %	10 %	
	P <sub>2</sub> O <sub>5</sub>	0.001 %	40 %	
	Cr <sub>2</sub> O <sub>3</sub>	0.004 %	10 %	
	BaO	0.01 %	10 %	
	ZnO	0.002 %	1 %	
	ZrO <sub>2</sub>	0.01 %	1.5 %	
	V <sub>2</sub> O <sub>5</sub>	0.002 %	10 %	
	SO <sub>3</sub>	0.01 %	3.5 %	
	LOI	0.1 %	100 %	

# LITHOGEOCHEMISTRY

## IRON ORE ANALYSIS

Fused discs for XRF analysis provide robust and precise data for all iron ore matrices. Loss On Ignition (LOI) is determined separately at 1000oC. Sample is mixed with lithium tetraborate/metaborate flux followed by fusion and casting into glass discs. Fused discs are entirely homogeneous and eliminate matrix and grain size variability thus presenting an ideal sample to an extremely stable analytical platform. The data produced is of the highest assay quality and is verified with a full spectrum of iron ore specific certified reference materials.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>XF732</b>	<b>Standard suite of major oxides</b>			\$40.10
	SiO <sub>2</sub>	0.01 %	100 %	
	Al <sub>2</sub> O <sub>3</sub>	0.01 %	100 %	
	Fe	0.01 %	75 %	
	CaO	0.01 %	50 %	
	MgO	0.01 %	50 %	
	K <sub>2</sub> O	0.01 %	15 %	
	MnO	0.01 %	50 %	
	TiO <sub>2</sub>	0.01 %	20 %	
	P	0.001 %	10 %	
	Cr	0.001 %	10 %	
	LOI	0.1 %	100 %	
<b>XF732-EXT</b>	<b>Iron Ore Extended suite, 23 elements</b>			\$44.05
	V	0.002 %	5 %	
	Ba	0.005 %	10 %	
	Ni	0.001 %	8 %	
	Co	0.001 %	5 %	
	Cu	0.002 %	5 %	
	Pb	0.005 %	8 %	
	Zn	0.001 %	1.5 %	
	As	0.002 %	1.5 %	
	Sr	0.001 %	3 %	
	Zr	0.001 %	1 %	
	S	0.001 %	5 %	
	Na <sub>2</sub> O	0.01 %	8 %	
* Requires at least 12 g per sample				

## PHOSPHATE ROCK

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>XF740</b>	<b>Phosphate Rock Package, 11 elements (includes LOI)</b>			\$45.30
	SiO <sub>2</sub>	0.01%	100 %	
	Al <sub>2</sub> O <sub>3</sub>	0.01%	100 %	
	Fe <sub>2</sub> O <sub>3</sub>	0.01%	100 %	
	CaO	0.01%	80 %	
	MgO	0.01%	80 %	
	Na <sub>2</sub> O	0.01%	15 %	
	K <sub>2</sub> O	0.01%	15 %	
	MnO	0.01%	50 %	
	TiO <sub>2</sub>	0.01%	40 %	
	P <sub>2</sub> O <sub>5</sub>	0.01%	40 %	
	LOI	0.1%	100 %	

## XRF FOR BASE METAL BEARING SAMPLES

In addition to commonly reported major elements such as oxides, this XRF method also reports Cu, Pb, and Zn concentrations. The benefit of base metal determination by Li-borate fusion/XRF are the dynamic concentration ranges achievable, plus the absence of potential recovery issues that may exist with acid digestions where sulphur contents are high.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>LF725</b>	<b>Base Metals bearing Package 16 elements (includes LOI)</b>			\$41.80
	SiO <sub>2</sub>	0.01 %	100 %	
	Al <sub>2</sub> O <sub>3</sub>	0.01 %	100 %	
	Fe <sub>2</sub> O <sub>3</sub>	0.01 %	100 %	
	CaO	0.01 %	100 %	
	MgO	0.01 %	100 %	
	K <sub>2</sub> O	0.01 %	15 %	
	MnO	0.01 %	50 %	
	TiO <sub>2</sub>	0.01 %	50 %	
	P <sub>2</sub> O <sub>5</sub>	0.01 %	40 %	
	Cr <sub>2</sub> O <sub>3</sub>	0.01 %	10 %	
	Ba	0.01 %	58.8 %	
	Cu*	0.01 %	8 %	
	Pb*	0.01 %	25 %	
	Zn*	0.01 %	24 %	
	LOI	0.1 %	100 %	
*Over limit analysis up to 40% Cu; 75% Pb; 60% Zn.				

# LITHOGEOCHEMISTRY

## NICKEL LATERITE ANALYSIS

Exploration and evaluation of nickel laterite requires total determination and mass balance accounting of the major rock-forming elements and the commodity elements Ni, Cu and Co. BVM delivers these requirements by XRF or laser ablation.

### LATERITE STANDARD SUITE BY XRF

This package uses a predetermined amount of sample dried at 105°C to remove moisture to ensure that the hygroscopic nature of the material does not add error to the analysis. A test portion of that dried material is then fused in a platinum gold crucible with a lithium tetraborate flux and cast into a disc. Fused discs are analyzed by XRF. Another test portion of dried sample is roasted at 1000°C to determine the loss on ignition. Another test portion of dried sample is roasted at 1000°C to determine the loss on ignition.

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>XF720</b>	<b>Laterite Standard suite by XRF, 15 elements</b>			<b>\$45.30</b>
	SiO <sub>2</sub>	0.01 %	100 %	
	Al <sub>2</sub> O <sub>3</sub>	0.01 %	100 %	
	Fe <sub>2</sub> O <sub>3</sub>	0.01 %	100 %	
	CaO	0.01 %	50 %	
	MgO	0.01 %	50 %	
	K <sub>2</sub> O	0.005 %	15 %	
	MnO	0.002 %	50 %	
	TiO <sub>2</sub>	0.01 %	10 %	
	P <sub>2</sub> O <sub>5</sub>	0.001 %	15 %	
	Cr <sub>2</sub> O <sub>3</sub>	0.005 %	6.8 %	
	Ni	0.002 %	7.5 %	
	Co	0.001 %	3.5 %	
	Cu	0.002 %	8 %	
	Zn	0.001 %	1.5 %	
	LOI	0.1 %	100 %	
<b>XF722</b>	<b>Laterite Package including TC000 (C &amp; S)</b>			<b>\$54.05</b>

Laterite analytical methods incorporate special handling procedures to minimize moisture accumulation due to the hygroscopic nature of the material. Please contact us if you are interested in using other analytical methods not listed here for laterites.

### XRF SPECIFIC ELEMENTS BY FUSION

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>XF750-X</b>	<b>High Grade Tin and Tungsten Package for the first element</b>			<b>\$21.80</b>
	SnO <sub>2</sub>	0.01%	100 %	
	WO <sub>3</sub>	0.01%	100 %	
	<b>Additional element</b>			<b>\$4.30</b>

CODE	ELEMENT	DETECTION LIMIT	UPPER LIMIT	CAD
<b>LF700-X</b>	<b>High Grade Cesium Package for the first element</b>			<b>\$20.65</b>
	Cs	0.01%	30 %	
	<b>Additional element</b>			<b>BY QUOTE</b>



## LASER ABLATION PACKAGES

This package utilizes state-of-the-art laser ablation and ICP-MS instrumentation to analyze the fused glass disk from a Li-borate fusion digestion. It can be coupled with wavelength dispersive XRF to provide a complete total whole rock analysis.

- + Lower detection limits are comparable to traditional acid digestion methods.
- + XRF and LA-ICP-MS capabilities can be combined to extend the dynamic range, which removes the need for overlimit analyses (i.e., Sn from 0.2 ppm to percent level).
- + Simplification of the analytical process (only 1 digestion needed for major and trace whole rock characterization).
- + Safety and environmental advantages - there are no acids used in digestion.

## FUSED BEAD LASER ABLATION ICP-MS

CODE	ELEMENT	DETECTION LIMIT	CAD
LA001	Basic package, 34 elements		\$41.40
	Ag	0.01 ppm	
	As*	0.2 ppm	
	Ba	0.5 ppm	
	Be	0.2 ppm	
	Bi	0.2 ppm	
	Cd*	0.1 ppm	
	Ce	0.002 ppm	
	Co	0.1 ppm	
	Cr	1 ppm	
	Cs	0.01 ppm	
	Cu	2 ppm	
	Ga	0.1 ppm	
	Hf	0.01 ppm	
	In	0.05 ppm	
	La	0.01 ppm	
	Mn	1 ppm	
	Mo	0.2 ppm	
	Nb	0.01 ppm	
	Ni	2 ppm	
	Pb	1 ppm	
	Sb*	0.1 ppm	
	Sc	0.1 ppm	
	Sn	0.2 ppm	
	Sr	0.1 ppm	
	Ta	0.01 ppm	
	Te	0.2 ppm	
	Th	0.01 ppm	
	Ti	1 ppm	
	U	0.01 ppm	
	V	0.1 ppm	
	W	0.05 ppm	
	Y	0.02 ppm	
	Zn	5 ppm	
	Zr	0.5 ppm	

Method is performed at BVM's Perth, Australia facility. Shipping and Australian Customs charges may apply. Ask us about documentation and costs. \$300 minimum charge for service. \* Partially volatilized.

CODE	ELEMENT	DETECTION LIMIT	CAD
LA001-EXT	Extended package including LA001, 49 elements		\$53.80
	Rb	0.05 ppm	
	Re	0.01 ppm	
	Se*	5 ppm	
	Tl	0.2 ppm	
	Dy	0.01 ppm	
	Er	0.01 ppm	
	Eu	0.01 ppm	
	Gd	0.01 ppm	
	Ho	0.01 ppm	
	Lu	0.01 ppm	
	Nd	0.01 ppm	
	Pr	0.01 ppm	
	Sm	0.01 ppm	
	Tm	0.01 ppm	
	Yb	0.01 ppm	

\* Partially volatilized.

CODE	ELEMENT	DETECTION LIMIT	CAD
+ XRF	Major Oxides Package, Add-on		\$22.60
	Al <sub>2</sub> O <sub>3</sub>	100 ppm	
	CaO	100 ppm	
	Cl	10 ppm	
	Fe <sub>2</sub> O <sub>3</sub>	100 ppm	
	K <sub>2</sub> O	100 ppm	
	MgO	100 ppm	
	MnO	10 ppm	
	Na <sub>2</sub> O**	100 ppm	
	P <sub>2</sub> O <sub>5</sub>	10 ppm	
	SO <sub>3</sub>	10 ppm	
	SiO <sub>2</sub>	100 ppm	
	TiO <sub>2</sub>	10 ppm	
	LOI	0.01 %	
	Sum	0.01 %	

\*\* May not be available for some sample types.



**BUREAU  
VERITAS**

## **METALLURGY & MINERALOGY**

**OUR METALLURGICAL DIVISION OFFERS A FULL RANGE OF SERVICES FROM THE EARLY EXPLORATION PHASE THROUGH SCOPING, PRE-FEASIBILITY AND FEASIBILITY STUDIES FOR PROCESS DEVELOPMENT AND FLOWSHEET DESIGN INCLUDING LARGER-SCALE CONTINUOUS PILOT PLANT OPERATION.**

Our experience includes evaluation of precious metals, base metals and industrial minerals, environmental concerns and production aspects, using both conventional and newly developed technologies.

Mineralogical studies are critical to successful geological exploration and the processing of ores. We provide packages including: bulk mineralogical analysis (BMA), particle mineralogical analysis (PMA), trace mineral search (TMS), FieldScan (FS) using QEMSCAN, MLA Express and optical mineralogy for both thin and polished sections.

### MINERAL PROCESSING

Our Mineral Processing Laboratories are fully equipped to perform all metallurgical investigations from bench scale to demonstration tests. The focus is on developing a practical and economical flow sheet for plant operation, whether it is by adapting known technologies to new situations or by developing a new process.



#### ■ COMMUNICATION

- + Crushing
- + Grinding
- + Starkey SAG Design Test
- + Abrasion Index
- + Bond Rod & Ball Mill Work Index
- + Size Classification & Screening
- + Malvern Laser size analysis

#### ■ GRAVITY CONCENTRATION

- + Shaking tables
- + Hand panning
- + Mozley mineral separator
- + Elutriation
- + Spirals
- + Heavy media cones
- + Heavy media separation
- + Centrifugal concentrators (Falcon and Knelson)

#### ■ FLOTATION

- + Batch flotation
- + Locked-cycle flotation
- + Special gas media flotation
- + Column flotation
- + Reverse & flash flotation
- + Agglomeration flotation

#### ■ SOLID-LIQUID SEPARATION

- + Standard thickening procedures
- + Differential settling
- + Vacuum & pressure filtration

#### ■ MAGNETIC SEPARATION

- + Davis Tube
- + Drum separator
- + Belt separator
- + High gradient separator

### HYDROMETALLURGY

Our laboratory facilities are fully equipped to conduct a wide range of hydrometallurgical and bio-hydrometallurgical studies to recover valuable constituents from concentrates or raw minerals, using methods based on mass chemistry, where one or more of the mineral structures are changed, in an aqueous environment. Previous projects have ranged from the recovery of valuable metals from steel furnace dust, gold and silver extraction from refractory minerals, to heap leaching and solvent extraction of copper. These include the full scale up from individual batch tests through continuous bench tests to commercial sized pilot plant reactors.

#### TESTING CAPABILITIES INCLUDES:

- Cyanidation studies (Merrill Crowe, CIP and CIL procedures)
- Pressure leaching
- Bottle roll and tank leaching
- Counter current closed circuit tank leaching
- Column leaching up to one meter diameter (8 tonnes)
- Diagnostic / sequential leaching
- Solvent extraction
- Ion exchange
- Electrowinning
- Differential precipitation
- Bio-oxidation of refractory gold ores and concentrates
- Biological leaching of base metal ores and concentrates
- Biological heap leach simulation
- Cyanide and ammonia detoxification
- Galvanox copper recovery process, four-reactor pilot plant with elutriator and thickener



#### CONTINUOUS GRINDING GRAVITY FLOTATION PILOT PLANT

A complete ore treatment pilot plant, consisting of crushing – continuous grinding - gravity concentration – rougher/cleaner flotation - tailing thickening, can be assembled for any circuit combination, with throughput ranging from 1 to 5 tonnes per day, depending on ore hardness.

#### BANKABLE FEASIBILITY

Bureau Veritas Minerals is well recognized in the mining industry for value-added input and quality work. The Metallurgical Division is fully qualified to complete “bankability” testing and mill design. Over the past 28 years, our group has provided this level of service to many of the major mining engineering firms working within the mining industry. Our independence, reliability and accountability are firmly established.



## MINERALOGY AND PETROGRAPHY

Mineralogical studies are critical to successful geological exploration and the processing of ores.

### **BULK MINERAL ANALYSIS (BMA)**

This investigation is a one-dimensional linear analysis of point counting that provides a fast, basic study of mineral deportment.

- Complete mineral composition and deportment
- Elemental deportment
- Mineral association, liberation & grain size

### **PARTICLE MINERAL ANALYSIS (PMA)**

A two-dimensional mapping analysis that provides in-depth data for investigative purposes such as flotation or leaching process.

- Complete mineral composition
- Elemental deportment
- Mineral liberation and associations by size
- Effect of primary grind on mineral liberation
- Limiting grade recovery curves for the elements of interest

### **TRACE MINERAL SEARCH (TMS)**

TMS is a refinement of the PMA scan but only measures a sub-population of the particles based on a backscattered electron intensity threshold value.

- Target mineral (gold/silver/PGM/Bi/W/Mo) grain size
- Target elemental distribution across bearing minerals
- Mineral grain size and size distribution
- Mineral liberation and association
- Mineral locking characteristics

### **DIAGNOSIS OF METALLURGICAL PERFORMANCE**

Using the combined methods of QEMSCAN/MLA analysis to determine the sources that caused contamination in the final concentrates and the loss of target metals into the tailings in plant operations or metallurgical tests.

- Efficiency of primary grind and regrinding on the target mineral liberations
- The quality of final concentrates
- Status of the target minerals lost into the tailings
- Target mineral recovery by process streams, by mineral association class and by particle size
- Evaluation of potential improvement in the concentrate quality and metal recovery of plant operations or metallurgical test work

### **X-RAY DIFFRACTION**

XRD analysis is an effective, non-destructive method for the determination of sample mineralogy. BVM will provide you with a comprehensive report for each sample analyzed.



**BUREAU  
VERITAS**

# ACID ROCK DRAINAGE

**LABORATORY ACID ROCK DRAINAGE (ARD) PREDICTION TESTS ARE USED TO DETERMINE THE MOST APPROPRIATE DISPOSAL OPTIONS FOR WASTE ROCK AND TAILINGS IN ORDER TO MINIMIZE ENVIRONMENTAL IMPACT.**

Bureau Veritas offers the full range of ARD testing services for prediction studies and routinely conducts geochemical analysis, static testing and kinetic test programs. To better approximate site conditions, larger scale tests under specific environmental conditions can be conducted. To simulate underwater disposal of waste materials, custom subaqueous disposal (SAD) tests can be conducted to predict pore water quality, seepage quality to groundwater, and surface water quality.

## ACID ROCK DRAINAGE

### ACID ROCK DRAINAGE

Bureau Veritas has participated in the development of acid generation potential testing as well as sulphur speciation to support ARD prediction testing for many years. This testing is used to determine appropriate disposal options and storage for waste rock and tailings to minimize environmental impact.

Bureau Veritas offers the full range of ARD testing services for prediction studies and routinely conducts geochemical analysis, static testing and kinetic test programs. All test methods are offered including MEND, EPA, ASTM, and NAG methods. Custom tests include a variety of sequential leach tests. Our extensive laboratory facilities enable customized experimental design and testing over a wide range of simulated environmental conditions.

### SAMPLE PREPARATION

Bureau Veritas has a well-equipped sample preparation lab to provide sample drying, crushing, splitting and pulverizing when needed. Customized sample preparation is also offered.

### GEOCHEMICAL CHARACTERIZATION

Bureau Veritas offers a complete suite of geochemical analyses for characterization of overburden, waste rock and tailing materials by a variety of techniques.



### ACID ROCK DRAINAGE

#### GEOCHEMICAL TESTING

ANALYSIS	METHOD
Total Sulphur	Leco
Sulphide Sulphur	Pyrolysis
Total Carbon	Leco
Total Organic Carbon	Leco
Total Inorganic Carbon (TIC)	Leco
Trace Metals - Aqua regia digestion	
Trace Metals - Aqua regia digestion – low level	
Trace Metals – Multi acid digestion	
Trace Metals – Multi acid digestion – low level	
Whole Rock Analysis (WRA)	Lithium Borate Fusion & ICP-ES
Whole Rock Analysis (WRA)	XRF

#### MINERALOGICAL TESTING

ANALYSIS	METHOD
Reitveld XRD	Leco
Optical Microscopy on Polished Thin Section	Pyrolysis
QEMScan	Bulk Mineral Analysis (BMA)
QEMScan	Particle Mineral Analysis (PMA)



## ACID ROCK DRAINAGE

### ACID BASE ACCOUNTING (ABA)

Bureau Veritas offers all acid base accounting (ABA) procedures including standard Sobek, modified Sobek, Net Acid Generation (NAG), and siderite corrected NP. Analyses commonly include paste pH, fizz rating, total sulfur, sulfate sulfur, sulfide sulfur and neutralization potential (NP). We also calculate and provide maximum potential acidity (MPA), carbonate NP (NNP), net NP and NP ratio (NPR).

### STATIC WATER LEACHING PROCEDURES

Short-term water extraction (18 to 24h) procedures are routinely conducted to determine the presence of readily leachable contaminants. Methods we offer include the MEND SFE, SPLP, TCLP and Meteoric Water Mobility Procedure (MWMP). Extract analysis commonly includes pH, EC and dissolved metals by ICP-ES or ICP-MS. Other possible analytes include ORP, alkalinity, acidity, sulfate, TDS, Cl, F, Br, nitrate-N, nitrite-N, ammonia-N, TKN, total P, ortho-phosphate, CN species and other anions.



### STATIC TESTING

#### GEOCHEMICAL TESTING

ANALYSIS	METHOD
Acid Base Accounting Package – Modified Sobek, Standard Sobek	
Neutralization Potential – Modified Sobek NP, Standard Sobek NP Siderite Corrected NP	
Sulphur Speciation – Sulphate Sulphur, Sulphide Sulphur, Insoluble Sulphur	
Single Addition NAG	
Sequential NAG	
Kinetic NAG	AMIRA AMIRA
NAG Extract	AMIRA
Acid Base Characteristic Curve (ABCC)	MEND

### STATIC WATER EXTRACTIONS

ANALYSIS	METHOD
Shake Flask Extraction	MEND
SPLP	EPA Method 1312
Meteoric Water Mobility Procedure (MWMP)	ASTM E2242
Customized static tests and water extractions are also offered.	

### SEQUENTIAL EXTRACTIONS

ANALYSIS	METHOD
Sequential Batch Water Extractions	ASTM D4793
Sequential Extraction (6 Step)	Tessier
Sequential Extraction (7 Step)	Dold
Sequential Extraction (3 Step)	BCR
Customized static tests and water extractions are also offered.	



## ACID ROCK DRAINAGE

### HUMIDITY CELL TESTS — MEND AND ASTM D5744 METHODS

These tests are used to evaluate the long-term weathering characteristics of mine waste materials disposed under subaerial conditions. Tests are run in strict adherence to standard procedures. Possible analyses of leachates include: pH, EC, ORP, electrical conductivity, TDS, hardness, sulfate, anions (nitrate, nitrite, chloride, fluoride, phosphate, ortho-phosphate, TKN, ammonia), alkalinity, acidity, Hg by CVAF, and dissolved metal scans by ICP-ES or ICP-MS. While similar to humidity cell testing in some ways, these tests simulate site waste disposal conditions (such as saturated, non-saturated or partially saturated) more closely and at larger scale than humidity cells.

### LEACH COLUMNS (LYSIMETERS)

While similar to humidity cell testing in some ways, these tests simulate site waste disposal conditions (such as saturated, non-saturated or partially saturated) more closely. Water is typically added in a trickle leach fashion, but periodic flushings are possible to better simulate field conditions. Analyses that can be conducted on leachate water are the same as those for humidity cell tests.

### SUBAQUEOUS DISPOSAL COLUMNS

These tests simulate underwater disposal of tails or wasterock and the impacts of such disposal on the water system. Clear cast acrylic type column material is used. These tests often incorporate a series of ports, which enable sampling of surface water and pore water within the waste material. These tests can be operated under anoxic conditions using nitrogen or argon to displace oxygen. A custom in-line sampling port can be installed for in-situ analysis of selected parameters such as pH, Eh, ORP and dissolved oxygen. Analyses conducted on the water samples are the same as those for leach column tests, with the addition of dissolved oxygen analysis.

### OTHER NON-STANDARD TESTS

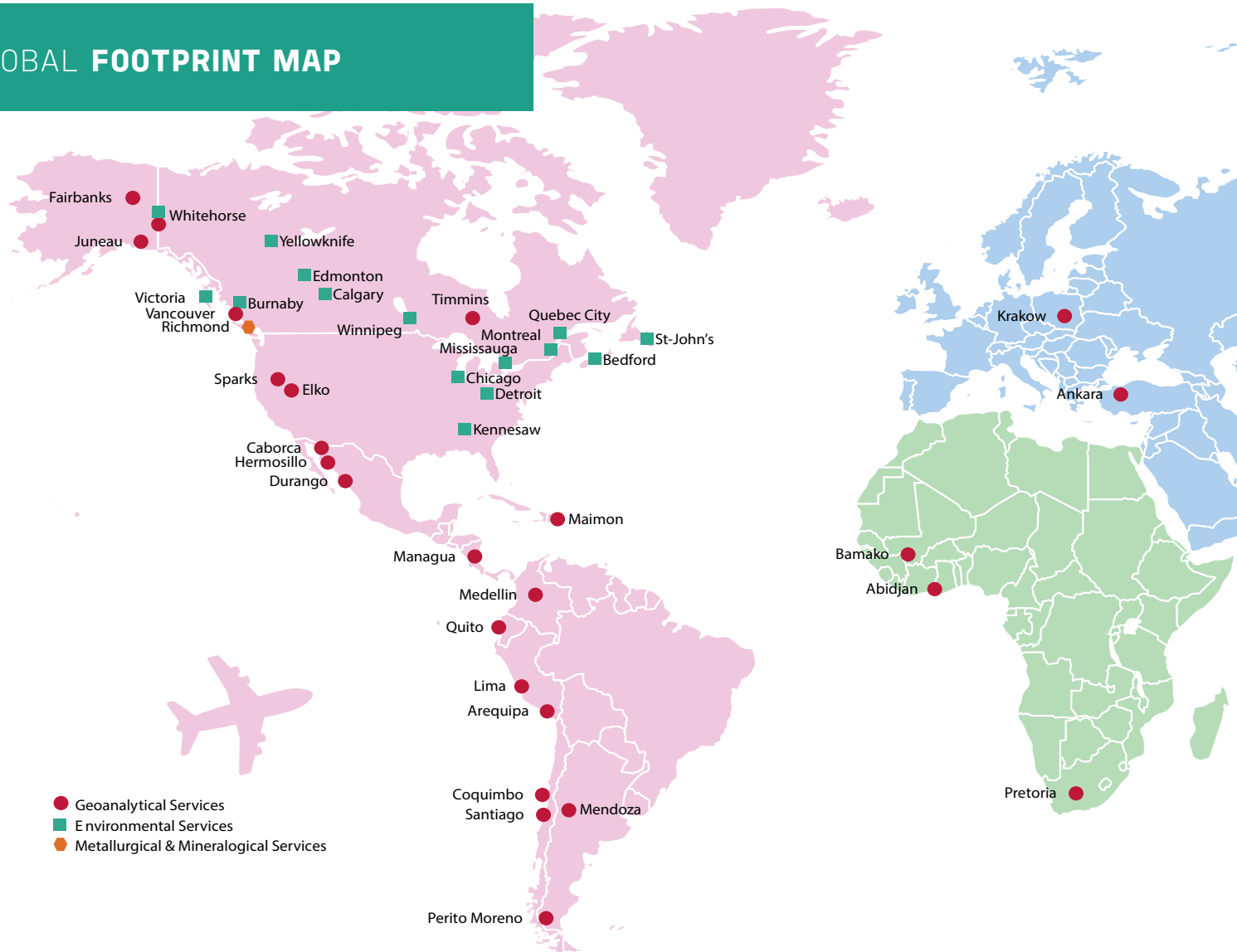
Bureau Veritas has the ability to construct and operate customized test systems for the purpose of ARD and/or metal leaching prediction. This allows for investigation of scaled-up tests or custom environmental conditions to simulate field conditions. Larger scale versions of the humidity cell and static water leach tests, as well as barrel tests, are offered. These provide a larger volume of leach water, which may be required for atypical water analyses such as radionuclides investigation, confirmation of novel controls, or prevention measures. Also, customized sequential leach tests are offered.

### KINETIC TESTING

ANALYSIS	METHOD
Humidity Cell Test	MEND
Humidity Cell Test	ASTM
Subaerial Column Test	Custom
Subaqueous Column Test – Aerobic conditions	Custom
Subaqueous Column Test – Anoxic conditions	Custom
Partially Saturated Column Test	Custom



# GLOBAL FOOTPRINT MAP



- Geoanalytical Services
- Environmental Services
- Metallurgical & Mineralogical Services

## ARGENTINA

- MAIPU, MENDOZA  
Tel: +54 261 524 0456/7
- PERITO MORENO  
Tel: +54 11 663 26402

## AUSTRALIA

- ADELAIDE  
Tel: +61 8 8416 5200
- CARDIFF  
Tel: +61 2 4902 4858
- KALGOORLIE  
Tel: +61 8 9021 7155
- PERTH  
Tel: +61 8 6218 5700
- WHYALLA  
Tel: +61 8 8647 6500

## CANADA

- BEDFORD, NS  
Tel: +1 902 832 4852  
Toll free: +1 800 565 7227

- BURNABY, BC  
Tel: +1 604 734 7276  
Toll free: +1 800 665 8566

- CALGARY, AB  
Tel: +1 403 291 3077  
Toll free: +1 800 386 7247

- COURTENAY, BC  
Tel: +1 250 338 7786  
Toll free: +1 877 533 3313

- EDMONTON, AB  
Tel: +1 780 577 7100  
Toll free: +1 800 386 7247

- GRANDE PRAIRIE, AB  
Tel: +1 780 532 0227

- LONDON, ON  
Tel: +1 519 652 9444  
Toll free: +1 800 268 7396

- MISSISSAUGA, ON  
Environmental Services, Main Office  
Tel: +1 905 817 5700  
Toll free: +1 800 563 6266  
mining@bvlabs.com

- MONTREAL, QC  
Tel: +1 514 448 9001

- OTTAWA, ON  
Tel: +1 613 274 0573  
Toll free: +1 877 480 7272

- PORT HOPE, ON  
Tel: +1 905 885 8080

- QUEBEC CITY, QC  
Tel: +1 418 658 5784

- REGINA, SK  
Tel: +1 306 565 1008  
Toll free: +1 800 386 7247

- RICHMOND, BC  
Metallurgical & Mineralogical Services  
Tel: +1 604 272 8110  
metallurgy@ca.bureauveritas.com

- SAGUENAY, QC  
Tel: +1 418 543 3788

- SASKATOON, SK  
Tel: +1 306 249 1014  
Toll free: +1 800 386 7247

- ST. JOHN'S, NL  
Tel: +1 709 754 0203  
Toll free: +1 888 492 7227



# CONVERSION CHARTS & VALUATIONS

## OXIDES CONVERSION FACTORS

ELEMENT	CONVERSION FACTOR	OXIDE
Al	1.889	Al <sub>2</sub> O <sub>3</sub>
Ba	1.669	BaSO <sub>4</sub>
	1.116	BaO
Be	2.775	BeO
C	3.666	CO <sub>2</sub>
Ca	1.399	CaO
	2.497	CaCO <sub>3</sub>
Cr	1.461	Cr <sub>2</sub> O <sub>3</sub>
F	2.055	CaF <sub>2</sub>
Fe	1.286	FeO
	1.430	Fe <sub>2</sub> O <sub>3</sub>
K	1.205	K <sub>2</sub> O
Mg	1.658	MgO
	3.468	MgCO <sub>3</sub>
Mn	1.291	MnO <sub>2</sub>
Na	1.348	Na <sub>2</sub> O
Nb	1.431	Nb <sub>2</sub> O <sub>5</sub>
Ni	1.273	NiO
P	2.291	P <sub>2</sub> O <sub>5</sub>
Pb	1.077	PbO
Rb	1.094	Rb <sub>2</sub> O
S	2.497	SO <sub>3</sub>
	2.996	SO <sub>4</sub>
Si	2.139	SiO <sub>2</sub>
Sn	1.270	SnO <sub>2</sub>
Sr	1.185	SrO
Ta	1.221	Ta <sub>2</sub> O <sub>5</sub>
Th	1.138	ThO <sub>2</sub>
Ti	1.668	TiO <sub>2</sub>
U	1.179	U <sub>3</sub> O <sub>8</sub>
V	1.785	V <sub>2</sub> O <sub>5</sub>
W	1.261	WO <sub>3</sub>
Y	1.270	Y <sub>2</sub> O <sub>3</sub>
Zn	1.244	ZnO
Zr	1.351	ZrO <sub>2</sub>

1 Metric Tonne (MT) = 1000 kilograms = 2204.6 pounds

1 Short Ton (ST) = 907.2 kilograms = 2000 pounds

1 Long Ton (LT) = 1016 kilograms = 2240 pounds

## MESH TO MICRON CONVERSION CHART

OPENING	US STANDARD	TYLER
2.00 mm	10	9
1.70 mm	12	10
1.40 mm	14	12
1.18 mm	16	14
1.00 mm	18	16
850 µm	20	20
710 µm	25	24
600 µm	30	28
500 µm	35	32
425 µm	40	35
355 µm	45	42
300 µm	50	48
250 µm	60	60
212 µm	70	65
180 µm	80	80
150 µm	100	100
125 µm	120	115
106 µm	140	150
90 µm	170	170
75 µm	200	200
63 µm	230	250
53 µm	270	270
45 µm	325	325
38 µm	400	400

## ASSAY VALUATIONS

VALUE	PARTS PER MILLION (ppm)	METRIC TONNE	SHORT TON	LONG TON
1 Gram / MT	1	0.03215	0.02917	0.03266
1 Troy oz / MT	31.104	1	0.9072	1.106
1 Troy oz / ST	34.286	1.1023	1	1.120
1 Troy oz / LT	30.612	0.9842	0.8929	1

CONVERSION FOR WEIGHTS	TROY OZ.	AVOIRDUPOIS OZ.	GRAMS
1 Troy oz.	1	1.0971	31.104
1 Avoirdupois oz.	0.91146	1	28.35
1 Gram	0.03215	0.03527	1



**BUREAU  
VERITAS**

Shaping a World of Trust