Bureau Veritas Minerals Service Guide 2016

Rev 0 – Effective January 2016

Move Forward with Confidence

BUREAU VERITAS

TABLE OF CONTENTS

1 WELCOME TO BUREAU VERITAS GROUP

Since its founding in 1828, Bureau Veritas has grown and established itself as a world leading professional services organisation, providing Testing, Inspection and Certification services globally including; Consultancy, Analytical Laboratory Testing and Conformity Assessment services. Today Bureau Veritas boasts an unrivalled global reputation, and network, operating within 140 countries with over 1400 offices and laboratories.

Bureau Veritas' Testing, Inspection and Certification services are applied in the areas of Quality, Health, Safety and Environment and are provided across a diverse range of industry clients, including some of the largest mining, oil & gas, construction, manufacturing, energy, marine, transport, and infrastructure companies. Bureau Veritas specialises in providing an integrated global approach with its 66,000 experienced professionals, always seeking to offer quality, integrity and business confidence.

Bureau Veritas' core focus is the efficient and reliable delivery of a diverse range of quality testing and analytical information services. Today with a wealth of experience and the support and network from a global business, Bureau Veritas is your one-stop-shop for all of your testing requirements.

Mineral Laboratories

Bureau Veritas Minerals division has the largest laboratory network in Australia with 45 offices & labs nationally with over 2000 employees servicing over 5000 clients. As the industry leader in mineral services, Bureau Veritas provides services across a broad range of resources and commodities including but not limited to, iron ore, bauxite, nickel, copper, other base metals, uranium, gold, silver and other precious metals and the rare earth minerals. Bureau Veritas' Mineral Laboratories provide both Mineral Processing and Geoanalytical services.

Geoanalytical

- Sample Preparation - Robotics
- Sample Preparation - Traditional
- Hazardous Sample Preparation
- Wet Chemistry
- Fire Assay
- Physical Testing
- ICP AES and ICP MS
- AAS
- XRF
- Fused Bead Laser Ablation ICP-MS
- Hyper Spectral Analysis

Mineral Processing

- Comminution
- Sample Sizing
- Drop Tower
- Gravity Separation
- Magnetic Separation
- Davis Tube Recovery
- Heavy Liquid Separation
- Flotation
- Leaching
- Pilot Plant

Mineralogy

- Scanning Electron Microscopy (QEMSCAN)
- Quantitative X-Ray Diffraction (QXRD)
- HyLogger
- Asbestiform Identification
- Petrology / Petrography

Coal Laboratories

Bureau Veritas is the provider of a full spectrum of coal quality, coal technology and technical support services to the Australian coal industry. These services are offered from a comprehensive network of 10 facilities throughout the key coal activity centres. Services include:-

- Bulk Commodity Superintending
- Draught Survey Services
- Exploration Borecore Analysis
- CHPP Technical Support
- Minesite Environmental support services

Petroleum and Used Oil Laboratories

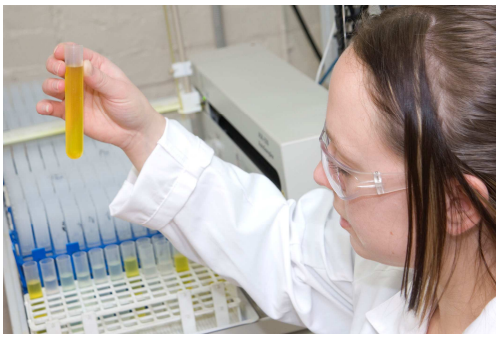
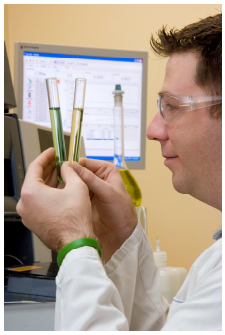
Bureau Veritas' Petroleum Services include:

- Crude oil assays
- Environmental analyses
- Gas and liquid compositions
- Gas distribution testing
- Industrial gas analysis
- Lubrication oil tests
- Oil geochemical analyses
- On-site gas, oil and water analyses
- Source rock analyses
- Water analyses
- Physical testing of petroleum liquids and bitumen

Bureau Veritas' Used Oil services are tailored for:-

- Condition Monitoring
- Machine and Lubricant Performance

Our experienced engineering staff offer expert interpretation of used oil analyses with up-to-date, relevant and informative comments.


2 INTRODUCTION

This guide is designed to outline some of the more common testing activities of Bureau Veritas Minerals' Geoanalytical Laboratories. Please contact your Bureau Veritas Minerals representative for additional information regarding our other services should you require methodology outside of this routine listing.

Bureau Veritas Minerals maintains an ISO9001.2000 quality system. All laboratories are either certified to this standard or work within the framework of the standard. Some sites are ISO 17025 accredited and NATA registered, please ask your representative for details.

Sample Submission

Sample Submission Forms are available from our website, or alternatively these can be emailed through at your request.

Hazardous Material and Other OH&S Considerations

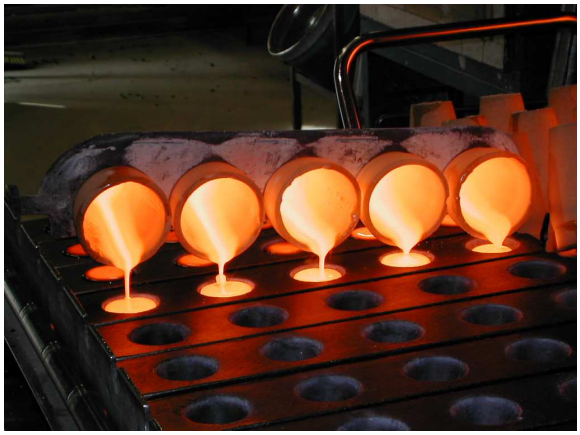
When submitting samples that are likely to contain hazardous substances (asbestiform minerals, radiation etc.), the laboratory must be notified by clear notation on the sample submission.

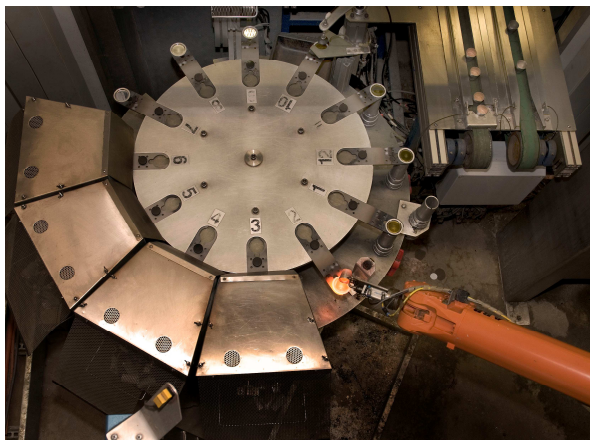
It is a Bureau Veritas Minerals requirement that clients clearly notify the laboratory regarding hazardous and potentially hazardous deliveries, such as those suspected of containing asbestos or radioactive substances in order to prevent exposure of staff.

Samples containing asbestos or radioactive substances will be set aside for preparation and analysis under controlled conditions in accordance with NH&MRC guidelines.

Australian Quarantine Inspection Services Information

Bureau Veritas Minerals is registered to receive samples under Quarantine and we are able to arrange customs clearance for importing your samples. External clearing agents are used to clear samples through customs, any costs incurred will be passed on. Bureau Veritas Minerals currently holds a permit to import quarantine material. We are able to import your samples on our import permit with a minimum of fuss. This permit plus appropriate templates for documentation will be emailed through upon request. Samples and packaging must be sterilised by heat treatment before they can be released.





3 QUALITY ASSURANCE

Sample Preparation

Bureau Veritas Minerals uses a variety of robotic and manual sample preparation systems. Robotic systems incorporate water washing of the grinding bowl & puck between every sample. Manual equipment is routinely cleaned as part of the sample preparation protocols.

Blank washes are utilised to ensure no contamination between individual jobs and mineral types. Blank materials are retained for analysis if required, or on request. Particle size analysis is conducted routinely in each batch to ensure the correct grind size is achieved.

Analysis

All Bureau Veritas Minerals laboratories work to documented procedures compliant with ISO 9001 Quality Management Systems. Rigorous quality control and quality assurance measures are applied throughout the entire process in our laboratories. Bureau Veritas Minerals also holds NATA ISO 17025 certifications at some sites.

Standard quality assurance procedures include:

- Analysis of blanks within each batch.
- The routine testing of suitable certified reference materials from national and international suppliers, in addition to in-house and client supplied standards. Standards will be selected based on the elements of interest, expected range of concentration, and the analytical method used.
- Duplicate samples are included in each batch to ensure that reproducible results are being achieved. Duplicate samples may be solutions, pulps or coarse splits as requested.
- Re-assay of anomalous results by our quality control staff using techniques considered appropriate for the level of analytes encountered.
- All sample results are reported. All blanks and standards are reported on request.

Detection Limit and Accuracy

Detection limits quoted in this services guide are set for standard sample types analysed for each method. In some cases better detection limits may be achievable. Please contact the laboratory to discuss your specific requirements so that we can determine the analysis method and detection limit that best suits your needs.

Results are reported in increments equivalent to the limit of detection, or a set number of significant figures, which ever is the largest. As a rule of thumb, however, accuracy equivalent to +/- 2 times detection limit is achievable, up to a concentration of 10 times the detection limit, and then +/- 5% of the value thereafter.

Detection limits may vary slightly between each of our laboratories due to differences in the configuration, instrumentation, and quality of consumables procured locally.

Bureau Veritas Minerals will carry out the preparation and analysis of samples to the best of its ability and with due regard to the importance of any sample submitted. However in the event of default by Bureau Veritas Minerals in providing services as defined by contracts, Bureau Veritas Minerals shall have no other liability for any negligent act, default, omission or breach of such contract. The liability of our company is limited by our General Terms and Conditions of Service.

At all times, the results of analysis must be interpreted as pertaining to the samples as they were received at the laboratory. Bureau Veritas Minerals reserves the right to vary these prices if the sample matrix is analytically complex or for small sample batches. Bureau Veritas Minerals will discuss these variations prior to commencement of work.

Quality Statement

At Bureau Veritas, we all strive for continuous improvement of our quality management process. We believe that our programs, supported by our Business Model and our Code of Ethics, will ensure the continual delivery of high quality products and services to our clients.

Our quality management system will in turn add value for our clients through the services offered and delivered.

In addition, our quality management system gives the company and its clients the confidence that the provision of services and products will be delivered consistently to predetermined high standards.

OUR PRINCIPLES

- Customer requirements can always be met.
- Company efficiency relies on individual competences, continuous training and employee commitment.
- All processes are described straightforwardly and continuously improved.

OUR MANAGEMENT SYSTEM

We are committed to quality, integrity and excellence in everything we do by:

- Cascading common objectives and monitoring relevant action plans.
- Reinforcing and supporting resource capabilities through extensive training.
- Ensuring sustainable progress through internal and external audits.

Since 1996 Bureau Veritas has been ISO 9001 certified through a recognized international independent certifier.

The Bureau Veritas Code of Ethics meets all IFIA (International Federation of Inspection Agencies) principles and requirements. Its implementation is regularly assessed by an external third party.

OUR COMMITMENTS

The entire line management, supported by our internal Quality network is accountable for the implementation of this policy and shall remain committed to:

- Continuously meet customer requirements
- Train and supervise employees
- Continuously audit and improve operations efficiency through Lean principles
- Capture and share Good Practices & Knowledge

By doing this, all Bureau Veritas employees will contribute to the first of our "Bureau Veritas Business Values": customer focus.

Didier Michaud-Daniel – Chief Executive Officer

31 October 2012

4 STANDARD SAMPLE PREPARATION SCHEMES

Bureau Veritas Minerals is an industry leader in the provision of quality sample preparation services. Automation and robotics are widely used within our laboratory network to ensure consistency and sample integrity is maintained through the preparation process. Our laboratories provide dedicated areas for different types of samples to be prepared including industry leading Haz Prep facilities.

CODE	DESCRIPTION OF SERVICE
AD001	**Minimum Job Charge** A minimum fee of $300.00 ex GST applies to each analytical batch submitted. *NB: Only applicable where the total invoice amount is less than $300.00 ex GST.*
PR001	**Sorting and Drying** Samples will be sorted and dried in clients own packaging or aluminium trays. Surcharge is applicable for samples received in plastic bags.
PR002	**Weighing** Samples weighed either pre or post drying as required.
PR101	**Primary Crushing** To Nominal 10mm – Up to 4 kg
PR102	**Primary Crushing** To Nominal 10mm – Over 4 kg (price per kg)
PR103	**Secondary Crushing** To Nominal 3mm – Up to 4 kg
PR104	**Secondary Crushing** To Nominal 3mm – Over 4 kg (price per kg)
PR105	**Secondary Crush & Split Combination** Smart Boyd process – To nominal -3mm
PR201	**Splitting** Samples split using a Riffle Splitter – Per split
PR202	**Splitting** Samples split using Rotary Sample Divider
PR203	**Splitting** Collection of second split post crushing – Per split
PR204	**Splitting** Collection of second pulp
PR301	**Pulverising** To 1.5 kg
PR302	**Robotic Pulverising** To 2.5 kg
PR303	**Pulverising** To 3.0 kg
PR305A	**Non-Ferrous Pulverising** Tungsten Carbide or Zirconia Bowl to 100g
PR305B	**Non-Ferrous Pulverising** Tungsten Carbide Bowl to 40g
PR305C	**Non-Ferrous Pulverising** Tungsten Carbide Bowl to 2g

CODE	DESCRIPTION OF SERVICE
PR307	**Barren Wash** Barren wash between samples if requested.
PR401	**Sieving** Dry sieving sample to collect a portion of a specified single mesh size (Not quantitative)
PR402	**Sieving** Dry sieving to quantitatively determine percentage passing a nominated mesh size
PR403	**Sieving** Additional samples wet sieved
PR404	**Laser Particle Sizing** To determine percentage passing the nominated particle size
PR405	**Laser Particle Sizing** To determine particle size distribution
PR501	**Composite Preparation** Preparation of composites as required.
PR601	**Hazardous Sample Preparation Surcharge** Surcharge for preparation of fibrous and potentially hazardous materials
PR602	**Hazardous Weighing Surcharge** Surcharge for weighing of fibrous and potentially hazardous pulps prior to analysis
PR701	**Roasting and Ashing** Samples of high organic or carbon content may require ashing prior to analysis.
QU001	**AQIS Compliance Fee** Batch Fee to comply with Australian Quarantine Import Regulations.

5 STORAGE, RETURN & DISPOSAL OF SAMPLES

Samples that have been submitted for analysis are retained at our laboratories for a limited time only, after which storage fees will apply.

CODE	DESCRIPTION OF SERVICE
ST001	**Sample Storage** Storage of bulk residues and coarse splits after 30 days from issue of final report.
ST002	**Sample Storage** Storage of pulps after 60 days from issue of final report.
ST003	**Sample Return** Pulps, bulks and residues collected and organised for return or on forwarding to the client. Transport costs for the return of samples will be on-charged at cost.
ST004	**Extraction of pulp samples** Extraction of pulp samples for 3rd party analytical check work.
EN001	**Environmental Fee** Environmental fee for disposal of pulps, bulk residues, coarse splits and wastes generated through the analytical processes in accordance with current government requirements. Additional fees may be levied for specific disposal requirements.
EN002	**Lead Waste Disposal Fee** Environmentally responsible disposal of waste

6 GOLD & PRECIOUS METAL ANALYSIS

This section contains several analytical options for traditional Fire Assay, Cyanide Leaches, and Aqua Regia digestions with gold only or gold and trace metals analysis.

Fire Assay

CODE	DESCRIPTION OF SERVICE
LEAD COLLECTION FIRE ASSAY	
FA001	**Lead Collection Fire Assay- AAS** Nominal 40g charge analysed. Silver used as secondary collector, Au is determined with AAS finish. Nature of the sample and/or lower sample weights may compromise detection limits. Detection limits in ppm. Gold only (0.01) by AAS finish
FA002	**Lead Collection Fire Assay – ICP-AES** Nominal 40g charge analysed. Silver used as secondary collector, Au, Pt, Pd determined with ICP quantification. Nature of the sample and/or lower sample weights may compromise detection limits. Detection limits in ppb. By ICP-AES Au (1) Pt (5) Pd (5)
FA003	**Lead Collection Fire Assay – ICP-MS** Nominal 40g charge analysed. Silver used as secondary collector, Au, Pt, Pd determined with ICP quantification. Nature of the sample and/or lower sample weights may compromise detection limits. Detection limits in ppb. By ICP-MS Au (1) Pt (1) Pd (1) *Note: FA002/003 - Bureau Veritas routinely determines and reports Platinum and Palladium simultaneously with Au, at no additional cost.*
FA004	**Fire Assay Lead Collection with Palladium Secondary Collection** Nominal 40g charge analysed for Au, Pt, Rh routinely by ICP-MS. Detection limits in ppb. Au (1) Pt (1) Rh (1)
SCREEN FIRE ASSAY	
FS001	**Gold by Screen Fire Assay** - (75µm, 106µm, 150µm) based on 1kg Samples are sieved through nominated mesh size using Nylon sieve cloth. The whole of the coarse fraction (including the cloth) is fire assayed to determine the portion of Gold contained in the coarse fraction. The fines are analysed by fire assay in duplicate. The following are reported: • Total Sample weight (g) • Wt + fraction • Au in coarse fraction • Duplicate Au in fines • Weighted Average of Au for whole sample
FIRE ASSAY NICKEL SULPHIDE COLLECTION	
FN001	**Fire Assay Nickel Sulphide Collection** NiS collection uses a nominal 25g of sample, mixed with flux and fired at 1200ºC ensuring total dissolution of sample matrix including chromite. For a robust analysis a minimum of 150gms of sample is required. ICP-MS Finish - Detection limits in ppb. Au (1) Pt (1) Pd (1) Rh (1) Ru (1) Os (1) Ir (1)

CODE	DESCRIPTION OF SERVICE
FN002	**Fire Assay Nickel Sulphide Collection – low level determination** This technique offers a high sensitivity variation on FN001 method. This method is intended for PGE concentrations below 100ppb. ICP-MS Finish - Detection limits in ppb. Au (0.5) Pt (0.5) Pd (0.5) Rh (0.1) Ru (0.1) Os (0.1) Ir (0.1)

Aqua Regia Digest

A nominal 40g charge of pulverised sample is digested with Aqua Regia in a water bath. An aliquot of the digest solution is then taken and analytes are determined by AAS or ICP as required. Due to the high sensitivity of the ICP-MS, lower detection limits are possible without further pre-concentration (solvent extraction) of the gold.

Although some base metals may dissolve quantitatively, in the majority of geological matrices, data reported from an Aqua Regia leach should be considered as representing only the leachable portion of the particular analyte. The recovery percentages for many analytes from more resistive minerals can be very low, but the acid leachable portion can also be an excellent exploration tool. In order to be able to report the widest possible concentration range, this method uses both the ICP-MS and the ICP-AES techniques.

CODE	DESCRIPTION OF SERVICE
AR001	**Aqua Regia** Au (1 ppb)
AR005	**Aqua Regia** Au (0.5 ppb) Au is determined by ICP-MS directly from the acid extract. Bureau Veritas use ICP-MS for determination of Gold directly on the acid digest; hence many other elements may also be determined simultaneously.
AR003	**Aqua Regia** Au (0.01 ppm) - AAS determination Gold is determined by Atomic Absorption Spectroscopy after extraction into an organic solvent.
AR101	**Additional Elements – ICP-AES detection limits** Detection limits in ppm Ag (1) Al (100) As (5) Ba (1) Ca (100) Cd (1) Co (1) Cr (5) Cu (1) Fe (100) K (100) Li (10) Mg (100) Mn (1) Mo (2) Na (100) Ni (1) P (20) Pb (5) S (50) Sc (1) Sr (1) Ti (50) V (2) Y (5) Zn (5) Zr (1)
AR102	**Additional Elements – ICP-MS detection limits** *ppb otherwise detection limits are ppm. Ag (0.05) As (0.5) Ba (1) Bi (0.05) Cd (0.1) Ce (10)* Co (0.2) Cr (2) Cs (0.05) Cu (1) Dy (10)* Er (10)* Eu (2)* Ga (0.2) Gd (5)* Hg (0.05) Ho (5)* In (10)* Ir (5)* La (10)* Li (0.1) Lu (5)* Mo (0.2) Nd (10)* Ni (1) P (5) Pb (1) Pd (10)* Pr (5)* Pt (10)* Rb (0.05) Rh (5)* Ru (5)* Sb (0.05) Sc (0.5) Se (1) Sm (10)* Sn (0.2) Sr (0.1) Tb (5)* Te (0.2) Th (20)* Tl (0.1) Tm (5)* U (20)* W (0.1) Y (10)* Zn (1)

CODE	DESCRIPTION OF SERVICE					
AR200	**Mini Aqua Regia Digest (Small scale < 5.0g sample)**					
	The mini aqua regia digest provides a cost effective method for acid soluble trace elements in sulphide and iron rich matrices. Although this is not a total digest, the refractory elements are included since they may be useful for element profiling purposes. This digest is NOT recommended for gold because of the small sample weight used.					
AR201	**ICP-AES detection limits**					
	Ag (1)	Al (100)	As (5)	Ba (1)	Ca (100)	Cd (1)
	Co (1)	Cr (5)	Cu (1)	Fe (100)	K (100)	Li (10)
	Mg(100)	Mn (1)	Mo (2)	Na (100)	Ni (1)	P (20)
	Pb (5)	S (50)	Sc (1)	Sr (1)	Ti (50)	V (2)
	Y (5)	Zn (5)	Zr (1)			
AR202	**ICP-MS detection limits**					
	*ppb otherwise detection limits are ppm.					
	Ag(0.05)	As (0.5)	Ba (1)	Bi (0.05)	Cd (0.1)	Ce (10)*
	Co (0.2)	Cr (2)	Cs(0.05)	Cu (1)	Dy (10)*	Er (10)*
	Eu (2)*	Ga (0.2)	Gd (5)*	Hg(0.05)	Ho (5)*	In (10)*
	Ir (5)*	La (10)*	Li (0.1)	Lu (5)*	Mo (0.2)	Nd (10)*
	Ni (1)	P (5)	Pb (1)	Pd (10)*	Pr (5)*	Pt (10)*
	Rb (0.05)	Rh (5)*	Ru (5)*	Sb (0.05)	Sc (0.5)	Se (1)
	Sm (10)*	Sn (0.2)	Sr (0.1)	Tb (5)*	Te (0.2)	Th (20)*
	Tl (0.1)	Tm (5)*	U (20)*	W (0.1)	Y (10)*	Zn (1)

Cyanide Leach Analysis

Cyanide leach analysis is particularly useful when it is difficult to obtain representative samples from current sampling techniques. In general larger sample masses typically 20 to 50 times that of other techniques, are utilised, therefore assisting in limiting the effect of coarse gold in the sample matrix. The technique can be applied to the determination of small anomalies in exploration programs and can assist in establishing cyanide extraction potential for grade samples. Cyanide leaches are designed to detect the free gold and will in general not report the complexed gold in the sample. Additional elements may also be determined in the Cyanide extract.

Bulk Leach Extractable Gold

A pulverised sample is tumbled for 24 hours with 0.1% Cyanide solution at ambient temperature. After settling, a sample of the supernatant liquor is taken and gold is then determined by ICP-MS. New extraction vessels are used for every sample, thus eliminating the possibility of sample cross contamination. Gold determination by AAS is available, however a higher detection limit applies (0.1ppm)

CODE	DESCRIPTION OF SERVICE
BL001	**Bulk Leach Extractable Gold** – 500g sample Au (0.1ppb)
BL002	**Bulk Leach Extractable Gold** – 1kg sample Au (0.1ppb)
BL102	**Bulk Leach Extractable Gold** – 50g sample Au (0.1ppb)
EN003	**Cyanide Waste Disposal** Following cyanide leach tests, the supernatant solution is neutralised and disposed of responsibly.

Analysis of Leach Residue

Residual solids from the Cyanide leach are recovered by pressure filtration. The residues are washed, dried and then briefly milled to break up agglomerates, a sub-sample is then collected for further testing by Aqua-Regia digest or Fire Assay for residual Gold.

CODE	DESCRIPTION OF SERVICE
BL301	**Residual Solids Preparation** Au determination by either Fire Assay or Aqua Regia techniques is required subsequent to this preparation.

In addition to this guide, customised cyanide leach analyses are available from many Bureau Veritas Minerals Laboratories. Please enquire to our sales or customer services team who will be able to assist in building a specific package.

7 MULTI ELEMENT DIGEST TECHNIQUES – ICP

Bureau Veritas offers a wide range of multi-element packages to suit your analytical requirements. Bureau Veritas utilise high volume ICP-AES and ICP-MS instrumentation to offer a large range of high quality, low cost, analyses.

Acid Digest

CODE	DESCRIPTION OF SERVICE
SINGLE ACID DIGEST	
SA100	**Single Acid - Perchloric Acid Digest** An aliquot of sample is accurately weighed and digested with perchloric acid followed by a final dissolution in hydrochloric acid. This single acid attack is suitable for stream sediments, rocks and soils, etc. where normal acid soluble analytes are required, and for general base metal requirements. Please note that some mineralogies may not be fully attacked (e.g. chromites, spinels, clays). The nature of the samples may compromise detection limits. Detection limits in ppm.
SA101	**ICP-AES detection limits** Ag (1) Al (100) As (5) Cd (2) Co (2) Cr (5) Cu (2) Fe (100) Mn (5) Mo (2) Ni (2) P (5) Pb (5) Sc (1) V (2) Zn (1)
SA102	**ICP-MS detection limits** Ag (0.5) As (1) Ba (1) Be (0.1) Bi (0.1) Cd (0.5) Co (1) Cs (0.5) Cu (1) Ga (0.2) Ge (2) In (0.05) Li (0.5) Mo (0.5) Ni (2) Pb (1) Rb (0.2) Sb (0.1) Sc (2) Se (5) Sr (0.5) Te (0.2) Th (0.1) Tl (0.1) U (0.1) V (2) Zn (2)
MIXED ACID DIGEST	
MA100	**Mixed Acid Digest** An aliquot of sample is weighed and digested with a mixture of nitric, perchloric and hydrofluoric acids. The digestion temperature and time is carefully controlled to near dryness, followed by a final dissolution in hydrochloric acid. This digest approximates a 'total' digest in most samples. Some refractory minerals may not be fully attacked. High concentrations of some elements may require special treatment. This method is suitable for large production runs of samples with consistent matrices. The nature of the samples may compromise detection limits. Detection limits in ppm.
MA101	**ICP-AES detection limits** Ag (2) Al (100) As (10) Ba (2) Ca (100) Cd (2) Co (5) Cr (10) Cu (2) Fe (100) K (100) Li(10) Mg (100) Mn (2) Mo (5) Na (100) Ni (2) P (50) Pb (10) S (50) Sc (1) Sr (2) Ti (50) V (5) Y (10) Zn (2) Zr (2)

CODE	DESCRIPTION OF SERVICE					
MA102	**ICP-MS detection limits**					
	Ag (0.5)	As (1)	Ba (1)	Be (0.5)	Bi (0.1)	Cd (0.5)
	Ce (0.1)	Co (1)	Cs (0.1)	Cu (1)	Dy (0.05)	Er (0.05)
	Eu (0.05)	Ga (0.2)	Gd (0.2)	Hf (0.2)	Ho(0.02)	In (0.05)
	La (0.1)	Li (0.5)	Lu (0.02)	Mo (0.5)	Nb (0.5)	Nd(0.05)
	Ni (2)	Pb (1)	Pr (0.05)	Rb (0.2)	Re (0.1)	Sb (0.1)
	Sc (2)	Se (5)	Sm(0.05)	Sn (1)	Sr (0.5)	Ta (0.1)
	Tb (0.02)	Te (0.2)	Th (0.1)	Tl (0.1)	Tm(0.05)	U (0.1)
	W (0.5)	Y (0.1)	Yb (0.05)	Zn (2)	Zr (1)	
MA200	**Ore Grade Mixed Acid Digest**					
	An aliquot of sample is weighed and digested in a modified acid mixture which includes hydrochloric, nitric, perchloric and hydrofluoric acid according to mineral type and analyte concentration.					
	Where samples contain high sulphur, the digestion is modified to prevent losses through the oxidation of the sulphides and sulphates. The digestion temperature and time is carefully controlled, followed by a final dissolution in hydrochloric acid.					
	This digest approximates a 'total' digest in most samples. Some refractory minerals may not be fully attacked. High concentrations of some elements may require special treatment.					
	This method is suitable for samples with complicated matrices, high concentrations of some elements requiring special attention and shorter production runs.					
	Detection limits in ppm					
MA201	**ICP-AES detection limits**					
	Ag (5)	Al (100)	As (20)	Ba (5)	Ca(100)	Cd (5)
	Co (5)	Cr (10)	Cu (5)	Fe(100)	K (100)	Li (20)
	Mg(100)	Mn (2)	Mo (10)	Na(100)	Ni (5)	P (100)
	Pb (20)	S (100)	Sc (5)	Sr (5)	Ti (50)	V (10)
	Y(20)	Zn (5)	Zr (5)			
MA202	**ICP-MS detection limits**					
	Ag (0.5)	As (2)	Ba (1)	Be (0.5)	Bi (0.1)	Cd (0.5)
	Ce (0.1)	Co (1)	Cs (0.1)	Cu (1)	Dy (0.05)	Er (0.05)
	Eu (0.05)	Ga (0.2)	Gd (0.2)	Hf (0.2)	Ho(0.02)	In (0.02)
	La (0.1)	Li (0.5)	Lu (0.02)	Mo (0.5)	Nb (0.5)	Nd(0.05)
	Ni (2)	Pb (1)	Pr (0.02)	Rb (0.2)	Re (0.1)	Sb (0.1)
	Sc (2)	Se (10)	Sm(0.05)	Sn (1)	Sr (0.5)	Ta (0.1)
	Tb (0.05)	Te (0.2)	Th (0.1)	Tl (0.1)	Tm(0.02)	U (0.1)
	W (0.5)	Y (0.1)	Yb (0.05)	Zn (2)	Zr (1)	

Fusion Techniques

CODE	DESCRIPTION OF SERVICE
FUSED BEAD LASER ABLATION ICP-MS	
LA100	**Fused Bead Laser Ablation ICP-MS** Fused Bead Laser Ablation ICP-MS utilises high productivity robotic fusion technology with state of the art laser ablation and ICP-MS instruments to provide a fully extracted quantitative analysis for all elements. Detection limits are comparable to traditional multi acid digestion methods. The technique offers safety and environmental advantages as there are no acids used in digestion, and it is fast and repeatable. Detection limits in ppm.
LA101	**LA-ICP-MS detection limits**

Ag (0.1)	As (0.2)	Ba (0.5)	Be (0.2)	Bi (0.2)	Cd (0.1)
Ce (0.02)	Co (0.1)	Cr (1)	Cs (0.01)	Cu (2)	Dy (0.01)
Er (0.01)	Eu (0.01)	Ga (0.1)	Gd (0.01)	Ge (0.05)	Hf (0.01)
Ho (0.01)	In (0.05)	La (0.01)	Lu (0.01)	Mn (1)	Mo (0.2)
Nb (0.01)	Nd (0.01)	Ni (2)	Pb (1)	Pr (0.01)	Rb (0.05)
Re (0.01)	Sb (0.1)	Sc (0.1)	Se* (5)	Sm (0.01)	Sn (0.2)
Sr (0.1)	Ta (0.01)	Tb (0.01)	Te (0.2)	Th (0.01)	Ti (1)
Tl (0.2)	Tm (0.01)	U (0.01)	V (0.1)	W (0.05)	Y (0.02)
Yb (0.01)	Zn (5)	Zr (0.5)			

**partially volatilized*

PEROXIDE FUSION	
PF100	**Peroxide Fusion** An aliquot of sample is fused with Sodium Peroxide in either a zirconia crucible or alumina crucible. The melt is dissolved in dilute Hydrochloric acid and the solution analysed. This process provides complete dissolution of most minerals including silicates. Volatile elements are lost at the high fusion temperatures. Note: Al cannot be measured when alumina crucibles are used, and Zr cannot be measured when zirconia crucibles are used. (Nature of the sample may compromise detection limits) Detection limits in ppm.
PF101	**ICP-AES detection limits**

Ag (50)	Al (100)	As (100)	B (20)	Ba (20)	Ca(1000)
Co (20)	Cr (50)	Cu (50)	Fe (100)	K (1000)	Mg (100)
Mn (10)	Mo (50)	Ni (50)	P (100)	Pb (50)	S (100)
Sc (10)	Si (100)	Sr (50)	Ti (100)	V (50)	Zn (50)
Zr (10)					

PF102 **ICP-MS detection limits**

Ag (5)	As (10)	Ba (10)	Be (1)	Bi (1)	Cd (10)
Ce (0.5)	Co(10)	Cs (1)	Cu(10)	Dy (0.5)	Er (0.5)
Eu (0.2)	Ga (2)	Gd (2)	Ge (20)	Hf (2)	Ho (0.2)
In (0.2)	La (0.5)	Li (1)	Lu (0.2)	Mo (5)	Nb (5)
Nd (0.5)	Ni (20)	Pb (20)	Pr (0.2)	Rb (0.5)	Re (1)
Sb (2)	Sc (20)	Sm (0.5)	Sn (10)	Sr (1)	Ta (0.5)
Tb (0.2)	Th (0.5)	Tl (2)	Tm (0.2)	U (0.5)	W (5)
Y (1)	Yb (0.5)	Zr (10)			

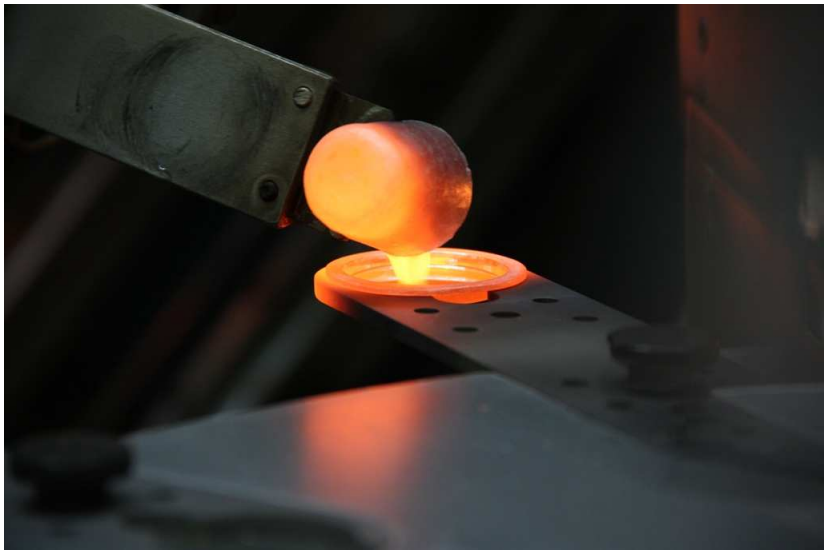
CODE	DESCRIPTION OF SERVICE
LITHIUM BORATE FUSION	
LB100	**Lithium Borate Fusion** An aliquot of sample is weighed and fused with lithium metaborate at high temperature in a Pt crucible. The fused glass is then digested in nitric acid. This process provides complete dissolution of most minerals including silicates. Volatile elements are lost at the high fusion temperatures. In some cases, elements are reported as oxides. (Nature of the sample may compromise detection limits)
LB101	**ICP-AES detection limits** Detection limits in ppm.

Ag (50)	Al (100)	As (50)	Ba (20)	Be (2)	Ca (100)
Ce (20)	Co (20)	Cu (50)	Fe (100)	K (100)	La (50)
Mg (100)	Mn (100)	Mo (50)	Na (100)	Nb (50)	Ni (50)
P (100)	Pb (50)	Si (100)	Sn (50)	Sr (50)	Ti (100)
V (20)	W (100)	Y (10)	Zn (20)		

LB102 **ICP-MS detection limits**

Detection limits in ppm.

Ag (5)	As (5)	Ba (2)	Be (5)	Bi (2)	Cd (5)
Ce (0.5)	Co(10)	Cs (1)	Cu(10)	Dy (0.5)	Er (0.5)
Eu (0.5)	Ga (2)	Gd (0.5)	Hf (1)	Ho (0.2)	In (0.2)
La (0.5)	Lu (0.2)	Mo (5)	Nb (5)	Nd (0.5)	Ni (10)
Pb (20)	Pr (0.2)	Rb (2)	Sb (2)	Se (20)	Sm (0.5)
Sn (5)	Sr (2)	Ta (0.5)	Tb (0.2)	Te (5)	Th (0.5)
Tl (2)	Tm (0.2)	U (0.5)	W (5)	Y (5)	Yb (0.5)
Zn (20)	Zr (2)				



8 MULTI- ELEMENT SCANS – ICP

CODE	DESCRIPTION OF SERVICE

SC101 **Mixed Acid Digest ICP AES Scan**

An aliquot of sample is accurately weighed and digested with a mixture of nitric, perchloric and hydrofluoric acids. The digestion temperature and time is carefully controlled to near dryness, followed by a final dissolution in hydrochloric acid. This digest approximates a 'total' digest in most samples. Some refractory minerals may not be fully attacked. High concentrations of some elements may require special treatment. This method is suitable for large production runs of samples with consistent matrices.

Nature of the sample may compromise detection limits. Detection limits in ppm.

Ag(5)	Al (100)	As (20)	Ba (5)	Ca (100)	Cd (5)
Co (5)	Cr (10)	Cu (5)	Fe (100)	K (100)	Li (20)
Mg (100)	Mn (2)	Mo(10)	Na (100)	Ni (5)	P (100)
Pb (20)	S (100)	Sc (5)	Sr (5)	Ti (50)	V (10)
Y(20)	Zn (5)	Zr (5)			

SC202 **Mixed Acid Digest Full ICP Scan**

Samples are digested using a mixed acid digest. The digests are then analysed by ICP AES and ICP MS for the following element package. Nature of the sample may compromise detection limits. Detection limits in ppm.

Ag (0.5)	Al (100)	As (1)	Ba (1)	Be (0.1)	Bi (0.1)
Ca (100)	Cd (0.5)	Ce (0.1)	Co (1)	Cr (5)	Cs (0.1)
Cu (1)	Dy (0.05)	Er (0.05)	Eu (0.05)	Fe (100)	Ga (0.2)
Gd (0.2)	Hf (0.2)	Ho (0.02)	In (0.02)	K (100)	La (0.1)
Li (0.5)	Lu (0.02)	Mg (100)	Mn (2)	Mo (0.5)	Na (100)
Nb (0.5)	Nd (0.05)	Ni (2)	P (5)	Pb (1)	Pr (0.02)
Rb (0.2)	Re (0.1)	S (50)	Sb (0.1)	Sc (1)	Se (5)
Sm (0.05)	Sn (1)	Sr (0.5)	Ta (0.1)	Tb (0.02)	Te (0.2)
Th (0.1)	Ti (50)	Tl (0.1)	Tm(0.02)	U (0.1)	V (2)
W (0.5)	Y (0.1)	Yb (0.05)	Zn (1)	Zr (1)	

SC302 **ICP Scan (Mixed Acid Digest - Peroxide Fusion)**

Samples are digested using a mixed acid digest and also fused with Sodium Peroxide digest to ensure all elements are brought into solution. The digests are then analysed for the following elements: (Nature of the sample may compromise detection limits. Fusion detection limits will be offered to suit sample type and analyte needs).
Detection limits in ppm.

Ag (0.5)	Al (100)	As (1)	B (20)	Ba (1)	Be (0.5)
Bi (0.1)	Ca(100)	Cd (0.5)	Ce (0.1)	Co (1)	Cr (10)
Cs (0.1)	Cu (1)	Dy(0.05)	Er(0.05)	Eu(0.05)	Fe(100)
Ga (0.2)	Gd (0.2)	Hf (0.2)	Ho(0.02)	In (0.05)	K (100)
La (0.5)	Li (0.5)	Lu (0.02)	Mg (100)	Mn (2)	Mo (0.5)
Na (100)	Nb (0.5)	Nd (0.05)	Ni (2)	P (100)	Pb (1)
Pr (0.2)	Rb (0.2)	Re (0.1)	S (50)	Sb (0.1)	Sc (1)
Se (5)	Si (100)	Sm(0.05)	Sn (1)	Sr (0.5)	Ta (0.1)
Tb (0.02)	Te (0.2)	Th (0.1)	Ti (50)	Tl (0.1)	Tm (0.2)
U (0.1)	V (5)	W (0.5)	Y (0.1)	Zn (2)	Zr (1)
Yb (0.05)					

CODE	DESCRIPTION OF SERVICE
SC402	**Ore Grade, ICP Scan (Mixed Acid Digest - Peroxide Fusion)**

Samples are digested using a mixed acid digest and also fused with Sodium Peroxide digest to ensure all elements are brought into solution. The digests are then analysed for the following elements:

Ag (0.5)	Al (100)	As (2)	B (20)	Ba (1)	Be (0.1)
Bi (0.1)	Ca (100)	Cd (0.5)	Ce (0.1)	Co (5)	Cr (50)
Cs (0.1)	Cu (5)	Dy (0.05)	Er (0.05)	Eu (0.05)	Fe (100)
Ga (0.2)	Gd (0.2)	Hf (0.2)	Ho(0.02)	In (0.02)	K (1000)
La (0.1)	Li (0.5)	Lu (0.02)	Mg (100)	Mn (2)	Mo (0.5)
Na (100)	Nb (0.5)	Nd(0.05)	Ni (5)	P (100)	Pb (1)
Pr (0.02)	Rb (0.2)	Re (0.1)	S (100)	Sb (0.1)	Sc (2)
Se (10)	Si (100)	Sm(0.05)	Sn (10)	Sr (0.5)	Ta (0.1)
Tb (0.02)	Te (0.2)	Th (0.1)	Ti (100)	Tl (0.1)	Tm(0.02)
U (0.1)	V (10)	W (0.5)	Y (0.1)	Yb (0.05)	Zn (5)
Zr (1)					

(Nature of the sample may compromise detection limits. Fusion detection limits will be offered to suit sample type and analyte needs). Detection limits in ppm.

ICP Analysis Packages

Combinations of techniques and element suites can be combined to form analysis packages. Should you wish to learn more about this please make contact with our Customer Service Team who will be happy to discuss further with you.

Pressurised Microwave Digestions

Pressurised Microwave digestion with ICP-AES determination of Reactive Silica and Available Alumina. Samples will be pre-dried at 105ºC for a minimum of 3 hours prior to analysis. The analysis complies with ABEA conditions with digestions being carried out within a Microwave digestion system. Each digestion vessel contains a magnetic stirrer to ensure continuous mixing during the digestion.

CODE	DESCRIPTION OF SERVICE
MD001	**Microwave Digestion**
	Pressurised Microwave digestion (bauxite), with ICP determination (ABEA)
	R.SiO_2 (0.1%) AvAl (0.1%)
MD002	**Microwave Digestion**
	Pressurised Microwave digestion (bauxite), with ICP determination (WDIE)
	R.SiO_2 (0.1%) AvAl (0.1%)

Both Aluminium and Silicon will be determined in their respective sub-samples by ICP-Atomic Emission Spectrometry (ICP-AES).

9 X-RAY FLUORESCENCE ANALYSIS

XRF Fusion

XRF fusion techniques are suitable for the analysis of most mineralogical ores, metallurgical products and complex matrices. The method involves fusing a sub-sample of the prepared pulp with a lithium borate flux prior to introduction to the instrument. Corrections are made for inter-element and matrix effects to achieve results of the highest quality.

Fused bead followed by XRF Fluorescence Spectrometry is the preferred method of analysis of Iron Ores, Bauxites, Nickel Laterites, Mineral Sands, plus many other ores including Manganese, Chrome, Tantalum, Tin, Tungsten and Rare Earths. Bureau Veritas Minerals boasts the most comprehensive XRF facilities in the world utilising robotically serviced fusion machines and automated XRF Instruments, all sites use similar methodology and equipment and draw on the expertise available within the network for technical support.

Samples are fused into a glass disc using a Lithium Borate flux. For ore grade materials, flux composition and sample to flux ratios are varied to ensure the sample dissolves completely and that re-crystallisation does not occur as the melt is cooled. Oxidising agents may be added to ensure retention of Sulphur or conversion of certain elements to highest state. When these are added sodium normally cannot be measured.

Bureau Veritas Minerals offers the following XRF “Analytical Packages” for routine analysis.

CODE	DESCRIPTION OF SERVICE					
XRF ORE GRADE MATERIAL						
XF100	**Extended Iron Ore Suite**					
	Fused with 12:22 Lithium Borate flux.					
	LOI determined by RTGA (see LOI section for options). Detection limits in ppm.					
	Fe (100)	SiO_2 (100)	Al_2O_3 (100)	MnO (10)	TiO_2 (10)	CaO (100)
	MgO (100)	K_2O (10)	P (10)	S (10)	Na_2O (100)	Cu (10)
	Ni (10)	Co (10)	Cr (10)	Pb (10)	Zn (10)	As (10)
	Sn (10)	Sr (10)	Zr (10)	Ba (10)	V (10)	Cl (10)
	LOI (0.01%)					
XF101	**Bauxite**					
	Fused with 12:22 Lithium Borate flux.					
	LOI determined by TGA (see LOI section for options). Detection limits in ppm.					
	SiO_2 (100)	Al_2O_3 (100)	CaO (100)	Fe_2O_3 (100)	K_2O (100)	MgO (100)
	P_2O_5 (10)	SO_3 (100)	TiO_2 (100)	MnO (100)	BaO (100)	ZrO_2 (100)
	V_2O_5 (10)	Cr_2O_3 (10)	LOI (100)			
	Optional Extras:					
	Na_2O (100)	Ga_2O_3 (10)	ZnO (10)			
XF102	**Tin, Tantalum, Niobium Ores**					
	Fused with 12:22 Lithium Borate flux.					
	Detection limits in ppm.					
	Ta_2O_5 (10)	Nb_2O_5 (10)	SiO_2 (100)	Fe_2O_3 (100)	S (100)	As (100)
	U_3O_8 (100)	Sn (10)	ThO_2 (100)	TiO_2 (100)	WO_3 (100)	Sb (50)
	Optional Extras:					
	Al_2O_3 (100)	CaO (100)	K_2O (100)	ZrO_2 (100)	P_2O_5 (100)	MnO (100)
	MgO (100)					

CODE	DESCRIPTION OF SERVICE					
XF103	**XRF Partial Silicate Analysis**					
	Typically fused with 12:22 Lithium Borate flux. Includes LOI determined by RTGA or TGA.					
	Analysis may include the following elements:					
	SiO_2 (0.01%)	Al_2O_3 (0.01%)	Fe_2O_3 (0.01%)	TiO_2 (0.01%)	CaO (0.01%)	Na_2O (0.01%)
	K_2O (0.001%)	MgO (0.01%)	P_2O_5 (0.001%)	SO_3 (0.001%)	MnO (0.01%)	LOI (0.01%)
	Options Extras:					
	BaO (0.001%)	Cr_2O_3(0.001%)	V_2O_5 (0.001%)	SrO (0.001%)	Cl (0.001%)	
	Traces can also be reported if requested:					
	Cu (0.001%)	Co (0.001%)	Ni (0.001%)	Zn (0.001%)	As (0.001%)	Pb (0.001%)
XF200	**Basic Iron Ore Suite (Sodium not available)**					
	Fused with 12:22 Lithium Borate flux including 5% $NaNO_3$. Sodium nitrate is included as an oxidising agent with the flux to convert sulphides to sulphates therefore preventing loss of sulphur during fusion. It is not possible to report Na by XRF from this technique.					
	LOI determined by RTGA (see LOI section for options).					
	Detection limits in ppm.					
	Fe (100)	SiO_2 (100)	Al_2O_3 (100)	MnO (100)	TiO_2 (100)	CaO (100)
	MgO (100)	K_2O (100)	P (10)	S (10)	LOI (0.01%)	
XF201	**Nickel Laterite**					
	Fused with12:22 Lithium Borate flux including 5% $NaNO_3$.					
	Detection limits in ppm					
	Ni (10)	Co (10)	Fe (100)	Si (100)	Al (100)	Ca (100)
	Mg (100	Mn (10)	Zn (5)	Cu (5)	Cr (5)	As (10)
	Cl (50)					
	Optional extras:					
	SO_3 (10)	K_2O (10)	P_2O_5 (10)	TiO_2 (10)	LOI (0.01)	
XF202	**Chromite Ore**					
	Fused with 12:22 Lithium Borate flux including 5% $NaNO_3$.					
	Detection limits in ppm.					
	TiO_2 (100)	Fe_2O_3 (100)	Al_2O_3 (100)	SiO_2 (100)	MnO (100)	CaO (100)
	Cr_2O_3 (100)	MgO (100)	SO_3 (10)	P_2O_5 (10)		
	Optional Extras:					
	K_2O (100)	CuO (10)	NiO (10)	BaO (100)		
XF203	**Manganese Ore**					
	Fused with 12:22 Lithium Borate flux including 5% $NaNO_3$.					
	Detection limits in ppm.					
	TiO_2 (100)	Fe (100)	Al_2O_3 (100)	SiO_2 (100)	Mn (100)	CaO (100)
	MgO (100)	S (10)	P (10)	BaO (100)	K2O (10)	LOI (0.01)%
	Optional Extras:					
	Cr_2O_3 (100)	V_2O_5 (100)	As_2O_3 (10)			
XF204	**Mineral Sands (Ilmenite and Rutile)**					
	Fused with 12:22 Lithium Borate flux including 5% $NaNO_3$.					
	Detection limits in ppm.					
	TiO_2 (100)	Fe_2O_3(100)	SiO_2(100)	Al_2O_3(100)	MgO(100)	MnO(100)

CODE	DESCRIPTION OF SERVICE					
	ZrO_2(100)	P_2O_5(10)	V_2O_5(10)	Nb_2O_5(10)	SO_3(100)	CaO (100)
	CeO_2 (10)	SnO_2 (10)	U(10)	Th(10)	LOI (0.01)%	
	Optional Extras:					
	K_2O (100)	La_2O_3 (100)	As_2O_3 (10)	PbO (10)	BaO (10)	Co_3O_4 (10)
XF300	**Tungsten and Molybdenum Ore**					
	Fused with 12:22 Lithium Borate flux including 15% $NaNO_3$.					
	Detection limits in ppm.					
	Fe_2O_3 (10)	SiO_2 (100)	Al_2O_3 (100)	TiO_2 (100)	S (100)	MgO (100)
	K_2O (10)	Cr_2O_3 (10)	V_2O_5 (10)	Mo (10)	As_2O_3 (10)	P (10)
	WO_3 (10)					
	Optional Extras:					
	ZnO (10)	NiO (10)	Co (10)	Cu (10)	Pb (100)	Bi (10)
	Sn (100)	Nb_2O_5 (10)	Ta_2O_5 (10)	Sb_2O_3 (10)	BaO (100)	Mn (100)
	LOI					
XF301	**Phosphate Ore**					
	Fused with Lithium Borate flux.					
	Detection limits in ppm.					
	Al_2O_3 (100)	CaO (100)	K_2O (100)	Fe_2O_3 (100)	MgO (100)	MnO (100)
	Na_2O (100)	P_2O_5 (100)	SiO_2 (100)	TiO_2 (100)	U (50)	
	Optional Extras:					
	Cl (200)	S (100)	V (100)	Cr (50)		
XF400	**Nickel Sulphide Ore**					
	Fused with 12:22 Lithium Borate flux with 15% $NaNO_3$.					
	Detection limits in ppm.					
	Ni (100)	Cu (10)	Co (10)	Fe (100)	S (100)	As (10)
	MgO (100)	CaO (100)	SiO_2 (100)	Al_2O_3 (100)		
	Optional Extras:					
	Mn (10)	Zn (10)	Cr (10)	Cl (50)		
XF401	**Zircon (>60% ZrO_2)**					
	Fused with lithium carbonate / lithium borate flux.					
	Detection limits in ppm.					
	SiO_2 (100)	Al_2O_3 (100)	Fe_2O_3 (100)	ZrO_2 (100)	HfO_2 (10)	TiO_2 (10)
	P_2O_5 (10)	CaO (100)	CeO_2 (10)	U (10)	Th (10)	
	Optional extras:					
	MgO (100)	MnO (10)	SO_3 (10)			
XRF PRESSED POWDER						
XP001	**XRF Pressed Powder**					
	The sample is finely pulverised and a sub-split of the pulp is pressed into a briquette. XRF peak intensities are corrected for background, matrix effects and interfering elements. Pressed powders are suitable for trace levels from LLD to approximately 0.5%, otherwise fusion techniques are recommended. The accuracy of pressed powder results can be dependent on particle size and the mineralogy of the sample. Please refer to your local laboratory for further information.					

XRF Packages can be tailored to suit your requirements; other suites may be available upon request.

10 LOSS ON IGNITION

Loss on Ignition determinations are often included in the packaged sets of XRF determinations.

CODE	DESCRIPTION OF SERVICE
TG001	**Loss on Ignition** LOI – Loss on Ignition (0.01%) Loss on Ignition (conventional furnace, single temperature). Sample is dried at 105℃ and then ignited at 1000°C. LOI can be analysed at other te mperatures if requested.
TG002	**Thermo Gravimetric Analysis (TGA)** TGA LOI - Loss on Ignition (0.01%) Loss on Ignition is determined in fully programmable Thermo gravimetric systems in which temperature ramp rates, hold times and atmosphere are fully controllable. LOI can be reported at a number of temperatures from 105℃ to 1000℃. TGA can be analysed at other temperatures if requested.
TG003	**Robotic Thermo Gravimetric Analysis (RTGA)** RTGA LOI - Loss on Ignition (0.01%) Loss on Ignition is determined by robotic thermo-gravimetric systems where samples are transferred to four independently controlled furnaces using a robot. Loss on ignition may be determined for a maximum of three temperatures in this system. Maximum temperature 1000℃.

11 TOTAL COMBUSTION

CODE	DESCRIPTION OF SERVICE
TC001	**Total Combustion – Carbon** Total Combustion using a Carbon – Sulphur analyser, determines carbon.
TC002	**Total Combustion – Sulphur** Total Combustion using a Carbon – Sulphur analyser, determines sulphur.
TC003	**Total Combustion – Carbon and Sulphur** Total Combustion using a Carbon – Sulphur analyser, determines carbon and sulphur.
TC004	**Total Organic Carbon** Carbonate material is removed by reaction with Hydrochloric acid, and the residue is analysed by Total Combustion using a Carbon – Sulphur analyser.

12 GENERAL ANALYSIS

CODE	DESCRIPTION OF SERVICE
GC001A	**Moisture - Bulk** Bulk sample is oven dried at 105℃. Moisture is dete rmined gravimetrically.
GC001B	**Moisture - Pulp** Pulp sample is oven dried at 105℃. Moisture is dete rmined gravimetrically.
GC002	**pH in Solids** Determines pH in extracted solutions.
GC003	**Bulk Density** The sample is weighed suspended in air and in water.
GC004	**Pulp Density by Gas Pycnometer** By determining the volume of a weighed sample using a gas pycnometer which employs Boyle's Law, the density can be calculated.
GC005	**Neutralising Value** By acidification and determination of acid consumption.
GC006	**Chloride** Sodium Carbonate/ Potassium Carbonate Fusion Colourimetric technique.
GC007	**Fluoride** Sodium Carbonate/ Potassium Carbonate Fusion Specific Ion Electrode.
GC008	**Non Sulphide Nickel** Perchloric / Hydrofluoric acid digestion followed by ICP-AES.
GC009	**Sulphate Sulphur Digest** Sample is digested with Hydrochloric acid and evaporated to dryness twice before final leach in Hydrochloric acid.
GC010	**Sulphide Sulphur Digest** Sulphide content determined by difference: total sulphur less sulphate sulphur
GC011	**Acid Soluble Digest** Specialised digests are available upon request
GC012	**Kjeldahl Nitrogen and Ammonia**
GC101	**FeO Analysis** Ferrous Iron content of a sample is determined by an acid digestion followed by a volumetric titration.

13 SOLUTIONS

Detection limits are based on Potable Water, lower detection limits maybe available if required depending on matrix loading. If salt loading is high, samples will be diluted to remove interferences, possibly increasing detection limits.

Alkaline or acidic solutions from metallurgical testwork can be processed but detection limits are dependent on sample matrix and element concentrations.

CODE	DESCRIPTION OF SERVICE					
SO101	**ICP-AES detection limits** Detection limits in mg/L					
	Ag (0.01)	Al (0.01)	As (0.02)	B (0.01)	Ba (0.01)	Ca (0.01)
	Cd (0.01)	Co (0.01)	Cr (0.01)	Cu (0.01)	Fe (0.01)	K (0.1)
	Mg (0.01)	Mn (0.01)	Mo (0.02)	Na (0.1)	Ni (0.01)	P (0.05)
	Pb (0.02)	S (0.05)	Sc (0.01)	Si (0.05)	Sr (0.01)	Ti (0.01)
	V (0.02)	Zn (0.01)	Zr (0.01)			
SO102	**ICP-MS detection limits** Detection limits in µg/L					
	Ag (1)	As (10)	Au (0.01)	Ba (10)	Be (1)	Bi (1)
	Cd (10)	Ce (1)	Co (10)	Cs (1)	Cu (10)	Dy (1)
	Er (1)	Eu (1)	Ga (5)	Gd (5)	Ge (100)	Hf (10)
	Hg (1)	Ho (1)	In (1)	La (1)	Li (10)	Lu (1)
	Mo (10)	Nb (10)	Nd (1)	Ni (20)	Pb (50)	Pd (0.1)
	Pr (1)	Pt (0.05)	Rb (1)	Re (5)	Sb (5)	Sc (10)
	Se(100)	Sm (1)	Sn (20)	Sr (5)	Ta (1)	Tb (1)
	Te (10)	Th (1)	Tl (5)	Tm (1)	U (1)	W (10)
	Y (5)	Yb (1)	Zn (20)	Zr (10)		

14 WATER AND WASTEWATER ANALYSIS

The tests listed below can be performed by Bureau Veritas Group of laboratories. Please enquire with the customer service team at your local laboratory.

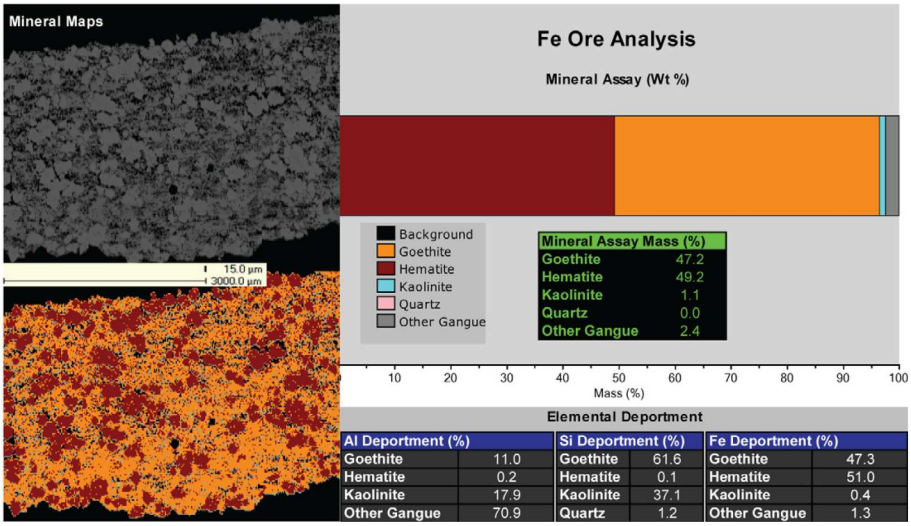
- Alkalinity (Hydroxide, Carbonate, Bicarbonate)
- Hydroxide
- Bicarbonate
- Carbonate
- Chloride
- Fluoride
- Nitrate (NO3) - Water
- Nitrate (NO3) - Acidic or Caustic solution
- Nitrite (NO2)
- Conductivity
- Hardness - Total by calculation from: Fe, Zn, Sr, Ca, Mg, Al, Mn
- Iron - Total
- Iron – Soluble
- Mercury
- pH

15 MINERALOGY

QEMSCAN (Quantitative Evaluation of Minerals by Scanning Electron Microscopy)

The QEMSCAN system integrates the Zeiss Leo scanning electron microscope (SEM) hardware with QEMSCAN software. The Bureau Veritas Minerals instrument is equipped with the very latest in QEMSCAN technology including four Bruker Silicon Drift Detectors (SDD) offering excellent light element detection and stability.

CODE	DESCRIPTION OF SERVICE
QS001	**Bulk Mineralogical Analysis** This technique is a one-dimensional Linear Analysis (point counting) method producing a series of single scan-lines across a SEM field of view; each one possibly intersecting several actual particles. Not suited to Fe ore analysis. Extremely high statistical populations giving robust mineral abundance data. Recommended for fast routine analysis (e.g. monthly composites) where mineral abundance is most important. Provides: • Mineral Abundance • Grain Size Estimation (indicative only) • Elemental Deportment • Mineral Associations (indicative only) • Indicative Liberation (area % only) • Indicative Locking (area % only) • Average Particle Density (indicative) • Size-by-size elemental & mineralogical reconciliation
QS002	**Particle Mineralogical Analysis** This technique uses two-dimensional Particle Mapping Analysis to provide visual representation of mineralogical associations (Mineral Maps), recommended for investigative projects. Best analysis mode for liberation measurements (e.g. for flotation or leaching) and is better suited to Fe-ore analysis than BMA. Provides: • Mineral Abundance • Grain Size Estimation • Elemental Deportment • Mineral Associations (visual representation) • Size-by-size elemental & mineralogical reconciliation • Locking (area % and surface area %) • Average Particle Density • Liberation (area % and surface area %) • Particles can be categorised in a variety of ways according to specific needs



CODE	DESCRIPTION OF SERVICE
QS003	**Specific / Trace Mineral Search** This technique uses two-dimensional Particle Mapping Analysis which provides visual representation of mineralogical associations (Mineral Maps). Only a pre-set subpopulation is measured, based on the premise that the phases of interest have a higher Back scatter electron (BSE) brightness than the bulk of the gangue phases (e.g. Gold, PGE's, Uranium). Once a bright phase is detected the entire particle is mapped. Recommended for good statistics on trace phases in a practical time frame. Replicate blocks will be required for some trace phases (depending on grade). Sample pre-concentration may also be required. Analysed in conjunction with either BMA or PMA to obtain gangue mineralogy. Provides: • Mineral Proportion (sub-population only) • Grain Size Estimation • Elemental Deportment • Mineral Associations (visual representation) • Liberation (area % and surface area %) • Locking (area % and surface area %) • Average Particle Density • Size-by-size elemental & mineralogical reconciliation
QS004	**FieldScan** This technique uses one-dimensional Linear Analysis, the sample is split into a grid with each grid acting as a field of view and each field of view is set with a minor overlap of its neighbouring fields so that particles may be stitched together. Recommended for large particles (i.e. >212um) and thin sections. May require the preparation and analysis of replicate polished blocks to gain a representative sample and adequate particle statistics. Provides: • Modal Mineralogy • Grain Size Estimation • Elemental Deportment • Mineral Associations • Liberation • Locking • Average Particle Density • Size-by-size elemental & mineralogical reconciliation

X-RAY Diffraction

X-Ray Diffraction analysis provides information on the presence and abundance of crystalline mineral phases in a sample. Samples are generally scanned between 2 and 80°2 Theta. The technique is unable to identify amorphous (non-crystalline) material. Chemical analysis is recommended in conjunction with XRD to assist with accurate phase identification.

CODE	DESCRIPTION OF SERVICE
XD001	**Quartz Content Determination** This technique provides quantitative determination of mass of quartz or cristobalite in dust on 25mm polycarbonate filters discs.
XD002	**Solid samples** Accuracy is +/-20% relative. Accuracy can be improved with additional ICP whole rock silicate analysis.
XD003	**Qualitative analysis** This technique enables identification of all detectable crystalline phases and their abundance estimated descriptively in terms of dominance. Abundance is expressed as Dominant, Major, Minor and Trace. The approximate relevant phase concentrations by weight are: Dominant > 50%; Major > 25 %; Minor > 2 %; Trace < 2%. Minimum sample weight depends on the average density of the sample, but is usually in the order of 0.5 – 1 g or ~ 0.2 cm^3.
XD004	**Quantitative analysis (QXRD)** This technique identifies all detectable crystalline phases and their abundance quantified and expressed as a table of normalised mineral abundances. The peaks present are identified by normal search methods and then quantified using the commercial software package Siroquant. Siroquant utilises the Rietveld refinement process and is able to directly calculate the relative weight percentages of the identified crystalline species present.
XD005	**Scan only** Sample scan only is provided for interpretation by third parties
XD006	**Detailed Mineralogy of Clays** This technique enables the identification of clay minerals including smectite, mixed layer clays and halloysite, after the XRD examination of bulk material, sedimented -2µm fraction. Sample weight of 25g to 50g is desirable (minimum 12g).
XD007	**Asbestos Identification Services** This technique identifies the presence and type of asbestos in un-cemented insulation, fibro-cement sheeting, flooring and sealant samples, loose dust, soils, ores etc using stereo and polarized light microscopy (PLM). XRD analysis is also available for floor tiles as a confirmation of the presence of mineral groups that include asbestos forming minerals. PLM is NATA accredited.

Fourier Transform Infra-Red (FTIR) Spectrometry

CODE	DESCRIPTION OF SERVICE
IR001	**Fourier Transform Infra-Red (FTIR) Spectrometry** The Fourier Transform Infra-Red (FTIR) technique measures light absorbed by a sample in the Infra-Red (IR) region of the light spectrum. To use the FTIR technique for the analysis of mineral samples, the spectrum of a number of samples that have been analysed by classical methods is collected. By using chemometric regression analysis, a mathematical correlation for each analyte is determined from the spectra, and then used to analyse unknown samples. Normal sample preparation schemes are used with the sample to produce a dried pulp. The FTIR spectra are collected without any additional preparation. There are no digests, fusions or other processes required. FTIR is a well-accepted analysis technique in the Bauxite industry; Bureau Veritas has successfully completed Bauxite programs using FTIR. Other ore types can be tested; however a consultative approach between the customer and laboratory will be needed to design the calibration set and analytes. Please contact your laboratory representative should you wish to design an analysis trial.

Petrography

Petrography and Mineragraphy are carried out by our highly experienced petrologist/ mineralogist using microscopes with photomicrographic facilities.

Brief descriptions of minerals do not include estimates of mineral percentages whereas routine descriptions do. As a rough guide, a brief description will occupy 0.5 – 1 page, whereas a routine description will occupy 1 – 1.5 pages of typescript. In addition, a brief petrographic summary is offered in which the main minerals and textural features are listed in tabular form.

Colour photomicrographics can be provided if required. Bureau Veritas' petrologist/ mineralogist is familiar with rocks and ores from a wide range of geological environments. Sample submission forms are available from Bureau Veritas or via our website: www.bureauveritas.com.au

CODE	DESCRIPTION OF SERVICE
PET1.2	Brief petrographic description (including thin section preparation).
PET1.2.1	Rocks not requiring impregnation
PET1.2.2	Rocks requiring impregnation
PET1.3	Routine petrographic description (including thin section preparation).
PET1.3.1	Rocks not requiring impregnation
PET1.3.2	Rocks requiring impregnation
PET2	Mineragraphy
PET2.1	Brief mineragraphic description (including polished section preparation).
PET2.2	Routine mineragraphic description (including polished section preparation).
PET3	Combined petrography & mineragraphy
PET3.1	Brief petrographic & mineragraphic description (including section preparation).
PET3.1.1	Rocks not requiring impregnation
PET3.1.2	Rocks requiring impregnation
PET3.2	Routine petrographic & brief mineragraphic description (including section preparation).
PET3.2.1	Rocks not requiring impregnation
PET3.2.2	Rocks requiring impregnation
PET3.3	Brief petrographic & mineragraphic description (including section preparation).
PET3.3.1	Rocks not requiring impregnation
PET3.3.2	Rocks requiring impregnation
PET4	Photomicrograph
PET5	Point Counting
PET5.1	500 points (not including section preparation).
PET5.2	1000 points (not including section preparation).
PET5.3	Secondary mineral content according to Australian Standards (not including section preparation).

Please contact your local mineralogist for further information on the above.

16 APPENDICES – ADDITIONAL INFORMATION

- Appendix 1: Detection Limits – AES Table
- Appendix 2: Detection Limits – MS Table
- Appendix 3: Periodic Table
- Appendix 4: Conversion Factors Table
- Appendix 5: British Standard Sieve Conversion Table
- Appendix 6: Bureau Veritas Minerals Contact Details

Appendix 1: Detection Limits – AES

Element	Single Acid	Aqua Regia	Mixed Acid Beaker	Mixed Acid Hotbox	Special Mixed Acid	Peroxide Fusion	Lithium Borate Fusion
Ag	1	1	1	2	5	50	50
Al	100	100	100	100	100	100	100
As	5	5	5	10	20	100	50
Au							
B						20	
Ba		1	1	2	5	20	20
Be							20
Ca		100	100	100	100	1000	100
Cd	2	1	1	2	5		
Ce			10	10			20
Co	2	1	1	2	5	20	20
Cr	5	5	5	10	10	50	
Cu	2	1	2	2	5	50	50
Fe	100	100	100	100	100	100	100
Ga							
In							
K		100	100	100	100	1000	100
La			5				50
Li		10	5	10	20		
Mg		100	100	100	100	100	100
Mn	5	1	1	2	2	10	100
Mo	2	2	5	5	10	50	50
Na		100	100	100	100		100
Nb			5				50
Ni	2	1	1	2	5	50	50
P	5	20	20	50	100	100	100
Pb	5	5	5	10	20	50	50
Pd							
Pt							
S		50	20	50	100	100	
Sb							
Sc	1	1	1	1	5	10	
Se							
Si						100	100
Sn							50
Sr		1	1	2	5	50	50
Ta							50
Ti		50	20	50	50	100	100
Tl							
U							
V	2	2	2	5	10	50	20
W							100
Y		5	5	10	20		10
Zn	1	5	2	2	5	50	20
Zr		1	1	2	5	10	

Appendix 2: Detection Limits – MS

Element	Single Acid	Aqua Regia	Mixed Acid Beaker	Mixed Acid Hotbox	Special Mixed Acid	Peroxide Fusion	Lith Borate Fusion	Lith Borate Laser Alation
Ag	0.5	0.05	0.5	0.5	0.5	50	5	0.1
As	1	0.5	1	1	2	10	5	0.2
Au		0.005						
Ba	1	1	1	1	1	10	2	0.5
Be	0.1		0.5	0.5	0.5	1	5	0.2
Bi	0.1	0.05	0.1	0.1	0.1	1	2	0.2
Cd	0.5	0.1	0.5	0.5	0.5	10	5	0.1
Ce		10	0.1	0.1	0.1	0.5	0.5	0.02
Co	1	0.2	1	1	1	10	10	0.1
Cr		2						1
Cs	0.5	0.05	0.1	0.1	0.1	1	1	0.01
Cu	1	1	1	1	1	10	10	2
Dy		0.01	0.05	0.05	0.05	0.5	0.5	0.01
Er		0.01	0.05	0.05	0.05	0.5	0.5	0.01
Eu		0.002	0.05	0.05	0.05	0.2	0.2	0.01
Ga	0.2	0.2	0.2	0.2	0.2	2	2	0.1
Gd		0.005	0.2	0.2	0.2	2	0.5	0.01
Ge	2					20		0.05
Hf		0	0.2	0.2	0.2	2	1	0.01
Hg		0.05						
Ho		0.005	0.02	0.02	0.02	0.2	0.2	0.01
In	0.05	0.01	0.02	0.05	0.02	0.2	0.2	0.05
Ir		0.005						
La		0.01	0.1	0.1	0.1	0.5	0.5	0.01
Li	0.5	0.1	0.5	0.5	0.5	1		
Lu		0.005	0.02	0.02	0.02	0.2	0.2	0.01
Mn								1
Mo	0.5	0.2	0.5	0.5	0.5	5	5	0.2
Nb			0.5	0.5	0.5	5	5	0.01
Nd		0.01	0.05	0.05	0.05	0.5	0.5	0.01
Ni	2	1	2	2	2	20	10	2
P		5						
Pb	1	1	1	1	1		20	1
Pd		0.01						
Pr		0.005	0.02	0.05	0.02	0.2	0.2	0.01
Pt		0.01						
Rb	0.2	0.05	0.2	0.2	0.2	0.5	2	0.05
Re			0.1	0.1	0.1	1		0.01
Rh		0.005						
Ru		0.005						
Sb	0.1	0.05	0.1	0.5	0.1		2	0.1
Sc	2	0.5	2	2	2	20		0.1
Se	5	1	5	5	10		20	5*
Sm		0.01	0.05	0.05	0.05	0.5	0.5	0.01
Sn		0.2	1	1	1	10	5	0.2
Sr	0.5	0.1	0.5	0.5	0.5	1	2	0.1
Ta			0.1	0.1	0.1	0.5	0.5	0.01
Tb		0.005	0.02	0.02	0.05	0.2	0.2	0.01
Te	0.2	0.2	0.2	0.2	0.2		5	0.2
Th	0.1	0.02	0.1	0.1	0.1	0.5	0.5	0.01
Ti								1
Tl	0.1	0.1	0.1	0.1	0.1	2	2	0.2
Tm		0.005	0.02	0.05	0.02	0.2	0.2	0.01
U	0.1	0.02	0.1	0.1	0.1	0.5	0.5	0.01
V	2	0.5						0.1
W		0.1	0.5	0.5	0.5	5	5	0.05
Y		0.05	0.1	0.1	0.1	1	5	0.02
Yb		0.01	0.05	0.05	0.05	0.5	0.5	0.01
Zn	2	1	2	2	2		20	5
Zr			1	1	1	10	2	0.5

Appendix 3: Periodic Table

PERIODIC TABLE

1 IA												13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1 **H** 1.00797 Hydrogen	2 IIA																2 **He** 4.0026 Helium
3 **Li** 6.939 Lithium	4 **Be** 9.0122 Beryllium											5 **B** 10.811 Boron	6 **C** 12.0112 Carbon	7 **N** 14.0067 Nitrogen	8 **O** 15.9994 Oxygen	9 **F** 18.9984 Fluorine	10 **Ne** 20.179 Neon
11 **Na** 22.9898 Sodium	12 **Mg** 24.305 Magnesium	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 **Al** 26.9815 Aluminium	14 **Si** 28.086 Silicon	15 **P** 30.9738 Phosphorous	16 **S** 32.064 Sulphur	17 **Cl** 35.453 Chlorine	18 **Ar** 39.948 Argon
19 **K** 39.102 Potassium	20 **Ca** 40.08 Calcium	21 **Sc** 44.956 Scandium	22 **Ti** 47.9 Titanium	23 **V** 50.942 Vanadium	24 **Cr** 51.996 Chromium	25 **Mn** 54.94 Manganese	26 **Fe** 55.847 Iron	27 **Co** 58.9332 Cobalt	28 **Ni** 58.71 Nickel	29 **Cu** 63.54 Copper	30 **Zn** 65.37 Zinc	31 **Ga** 65.37 Gallium	32 **Ge** 72.59 Germanium	33 **As** 74.9216 Arsenic	34 **Se** 78.96 Selenium	35 **Br** 79.909 Bromine	36 **Kr** 83.8 Krypton
37 **Rb** 85.47 Rubidium	38 **Sr** 87.62 Strontium	39 **Y** 88.905 Yttrium	40 **Zr** 9122 Zirconium	41 **Nb** 92.906 Niobium	42 **Mo** 95.94 Molybdenum	43 **Tc** [99] Technetium	44 **Ru** 101.07 Ruthenium	45 **Rh** 102.905 Rhodium	46 **Pd** 106.4 Palladium	47 **Ag** 107.87 Silver	48 **Cd** 112.4 Cadmium	49 **In** 114.82 Indium	50 **Sn** 118.69 Tin	51 **Sb** 121.75 Antimony	52 **Te** 127.6 Tellurium	53 **I** 126.904 Iodine	54 **Xe** 131.3 Xenon
55 **Cs** 132.905 Caesium	56 **Ba** 137.34 Barium	71 **Lu** 174.967 Lutetium	72 **Hf** 17849 Hafnium	73 **Ta** 180.948 Tantalum	74 **W** 183.85 Tungsten	75 **Re** 186.2 Rhenium	76 **Os** 190.2 Osmium	77 **Ir** 192.2 Iridium	78 **Pt** 195.09 Platinum	79 **Au** 197 Gold	80 **Hg** 200.59 Mercury	81 **Tl** 204.37 Thallium	82 **Pb** 207.19 Lead	83 **Bi** 208.98 Bismuth	84 **Po** [210] Polonium	85 **At** [210] Astatine	86 **Rn** [222] Radon
87 **Fr** [223.02] Francium	88 **Ra** [226.03] Radium	103 **Lr** [260] Lawrencium	104 **Rf** [261.11] Rutherfordium	105 **Db** [262.11] Dubnium	106 **Sg** [266.12] Seaborgium	107 **Bh** [264.12] Bohrium	108 **Hs** [269.13] Hassium	109 **Mt** [268.14] meitnerium	110 **Ds** [271] Darmstadtium	111 **Rg** [272] Roentgenium							

Lanthanide Metals:

57 **La** 6.17 Lanthanum	58 **Ce** 6.77 Cerium	59 **Pr** 6.8 Praseodymium	60 **Nd** 7.00 Neodymium	61 **Pm** 7.53 Promethium	62 **Sm** 7.54 Samarium	63 **Eu** 5.26 Europium	64 **Gd** 7.90 Gadolinium	65 **Tb** 8.23 Terbium	66 **Dy** 8.54 Dysprosium	67 **Ho** 8.80 Holmium	68 **Er** 9.05 Erbium	69 **Tm** 9.37 Thulium	70 **Yb** 6.98 Ytterbium

Actinide Metals:

89 **Ac** 10.07 Actinium	90 **Th** 11.72 Thorium	91 **Pa** 15.37 Protactinium	92 **U** 18.95 Uranium

Appendix 4: Conversion Factors

Obtained	Symbol	Sought	Multiply by
Aluminium	Al	Al_2O_3	1.8895
Antimony	Sb	Sb_2O_3	1.1971
Arsenic	As	As_2O_3	1.3203
Calcium	Ca	$CaCO_3$	2.4973
	Ca	CaF_2	1.9481
	Ca	CaO	1.3992
	Ca	$CaSO_4$	3.3967
Cerium	Ce	CeO_2	1.2284
Chromium	Cr	Cr_2O_3	1.4616
Cobalt	Co	Co_3O_4	1.3620
Copper	Cu	CuO	1.2518
Fluorine	F	CaF_2	2.0549
Hafnium	Hf	HfO_2	1.1793
Iron	Fe	Fe_2O_3	1.4297
	Fe	FeO	1.2865
	Fe	FeS	1.5741
Lanthanum	La	La_2O_3	1.1728
Lead	Pb	PbO	1.0772
	Pb	PbS	1.1547
Lithium	Li	Li_2CO_3	5.3240
Magnesium	Mg	$MgCO_3$	3.4683
	Mg	MgO	1.6581
Manganese	Mn	MnO	1.2912
Mercury	Hg	HgO	1.0798
	Hg	HgS	1.1598
Molybdenum	Mo	MoS_2	1.6681
Nickel	Ni	NiO	1.2725
Niobium	Nb	Nb_2O_5	1.4305
Phosphorus	P	P_2O_5	2.2914
	P_2O_5	$Ca_3(PO_4)_2$	2.1852
Potassium	K	K_2O	1.2046
Silicon	Si	SiO_2	2.1393
Sodium	Na	NaCl	2.5421
	Na	Na_2O	1.3480
Strontium	Sr	$SrSO_4$	2.0963
Tantalum	Ta	Ta_2O_5	1.2211
Thorium	Th	ThO_2	1.1379
Tin	Sn	SnO_2	1.2696
Titanium	Ti	TiO_2	1.6681
Tungsten	W	WO_3	1.2611
Uranium	U	U_3O_8	1.1792
Vanadium	V	V_2O_5	1.7852
Zinc	Zn	ZnO	1.2448
	Zn	ZnS	1.4904
Zirconium	Zr	ZrO_2	1.3508

Appendix 5: British Standard Sieve Conversion

(B.S. 410:1976)

Tyler Mesh Number	Nominal Aperture (microns)	Tyler Mesh Number	Nominal Aperture (microns)
10	1680	65	212
12	1400	80	180
14	1200	100	150
16	1000	115	125
24	710	150	106
28	600	170	90
32	500	200	75
35	420	250	63
42	355	270	53
48	300	325	45
60	250	400	38

Unit Conversion

To Convert	To	Multiply By
%	ppm	10,000
ppm	ppb	1,000
ppm	µg/L	1,000
ppm	g/tonne	1
mg/L	ppm	1
µg/L	ppm	0.001
µg/L	ppb	1
ng/L	ppt	1

Appendix 6: Bureau Veritas Minerals Contact Details

BUREAU VERITAS MINERALS LOCATIONS

VICTORIA	**MELBOURNE** *Head Office & Functional Support:*	Unit 3/ 435 Williamstown Road PORT MELBOURNE VIC 3207 Tel: (03) 9922 0700 Fax: (03) 8847 0750
WESTERN AUSTRALIA	**PERTH** *Head Sales Office* *Mineral Processing Laboratory* *Geoanalytical Laboratory*	6 Gauge Circuit CANNING VALE WA 6155 Tel: (08) 6218 5700 Fax: (08) 6218 5702
	PERTH *Geoanalytical Laboratory*	58 Sorbonne Crescent CANNING VALE WA 6155 Tel: (08) 9456 0404 Fax: (08) 9456 0403
	PERTH *Trade Samples Laboratory*	59 Crocker Drive MALAGA WA 6090 Tel: (08) 9249 1981 Fax: (08) 9249 1801
	KALGOORLIE *Geoanalytical Laboratory* *Mineral Processing Laboratory*	18 - 22 Atbara Street SOMMERVILLE KALGOORLIE WA 6430 Tel: (08) 9021 7155 Fax: (08) 9021 4268
	KALGOORLIE *Geoanalytical Laboratory*	20 Cunningham Road KALGOOLIE WA 6430 Tel: (08) 9091 7227 Fax: (08) 9091 7228
SOUTH AUSTRALIA	**ADELAIDE** *Sales Office* *Mineral Processing Laboratory* *Mineralogy Laboratory*	35 Cormack Road WINGFIELD SA 5013 Tel: (08) 8440 7100 Fax: (08) 8440 7199
	ADELAIDE *Geoanalytical Laboratory*	35-37 Stirling Street THEBARTON SA 5031 Tel: (08) 8416 5200 Fax: (08) 8234 2933
	WHYALLA *Geoanalytical Laboratory*	4-6 Jacobs Street WHYALLA SA 5600 Tel: (08) 8647 6500 Fax: (08) 8647 6530
NEW SOUTH WALES	**NEWCASTLE** *Geoanalytical Laboratory*	99 Mitchell Road CARDIFF NSW 2285 Tel: (02) 4902 4800 Fax: (02) 4902 4899
QUEENSLAND	**MOUNT ISA** *Geoanalytical Laboratory*	Lot 5 Industrial Road MOUNT ISA QLD 4825 Tel: (07) 4743 8484 Fax: (07) 4743 9439

For sales enquiries, please email: **bvaus@au.bureauveritas.com**
or call: **1300 MIN LABS**

www.bureauveritas.com.au