

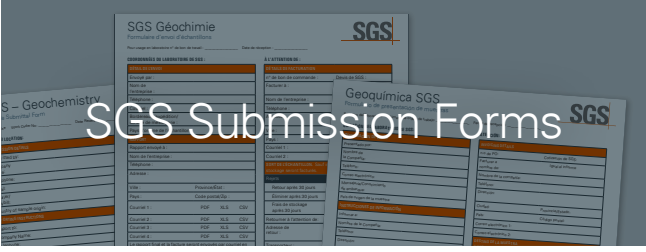
# Geochemistry Guide 2023

Trusted.  
Independent.  
Committed.



**SGS**

# Contents



# Introduction

Global economic growth will likely slow in 2023. Dealing with inflation, supply chains and logistics will be more difficult and all of these will impact the exploration and mining industries. We have seen a gradual slowing in the funds raised throughout 2022, and this will reduce the number of projects and spending.

SGS continues striving for fit for purpose sample preparation and analytical methodology to deliver accurate information. This is becoming more critical when making timely decisions advancing the programs. In 2022, SGS started up five new operations in four countries and continues to upgrade our analytical capacity in all major locations. SGS will continue expanding our footprint to provide better network coverage for our customers.

Whether it is precious, base, battery metals, Rare Earth Elements or bulk commodities, SGS's Geochemistry expertise offers technical and operational advice for your project.

As the leader in Geochemistry Analytical Services, SGS provides a global network of experts. Our one team approach means we are ready to be your strategic and sustainable partner.



**Lawrence Ng**  
Vice-President Geochemistry





# About SGS

Our leading testing, inspection and certification services add measurable value to society, our planet, people and communities. They reduce risk, improve efficiency, safety, quality, productivity and sustainability.

SGS operates in 125 countries. Our network of 96,000 employees working in 2,700 offices and laboratories enable a better, safer and more interconnected world.

The strength of our global network ensures that SGS is ready to meet customer demand, and deliver specialized, independent and reliable solutions to make your business faster, simpler and more efficient.

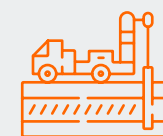
## 2021 HIGHLIGHTS :

**96,000 employees**  
for SGS

More than  
**170 Geochemistry**  
operations

**AAA rating**  
(Morgan Stanley Capital International's (MSCI)  
Environment Social Governance)

**Carbon Neutral**  
since 2014



- > Geology
- > Geochemistry
- > Mineralogy



- > Process design
- > Metallurgy
- > Mineralogy



- > Environmental testing
- > Metallurgy & mineralogy
- > Circular economy & sustainability management



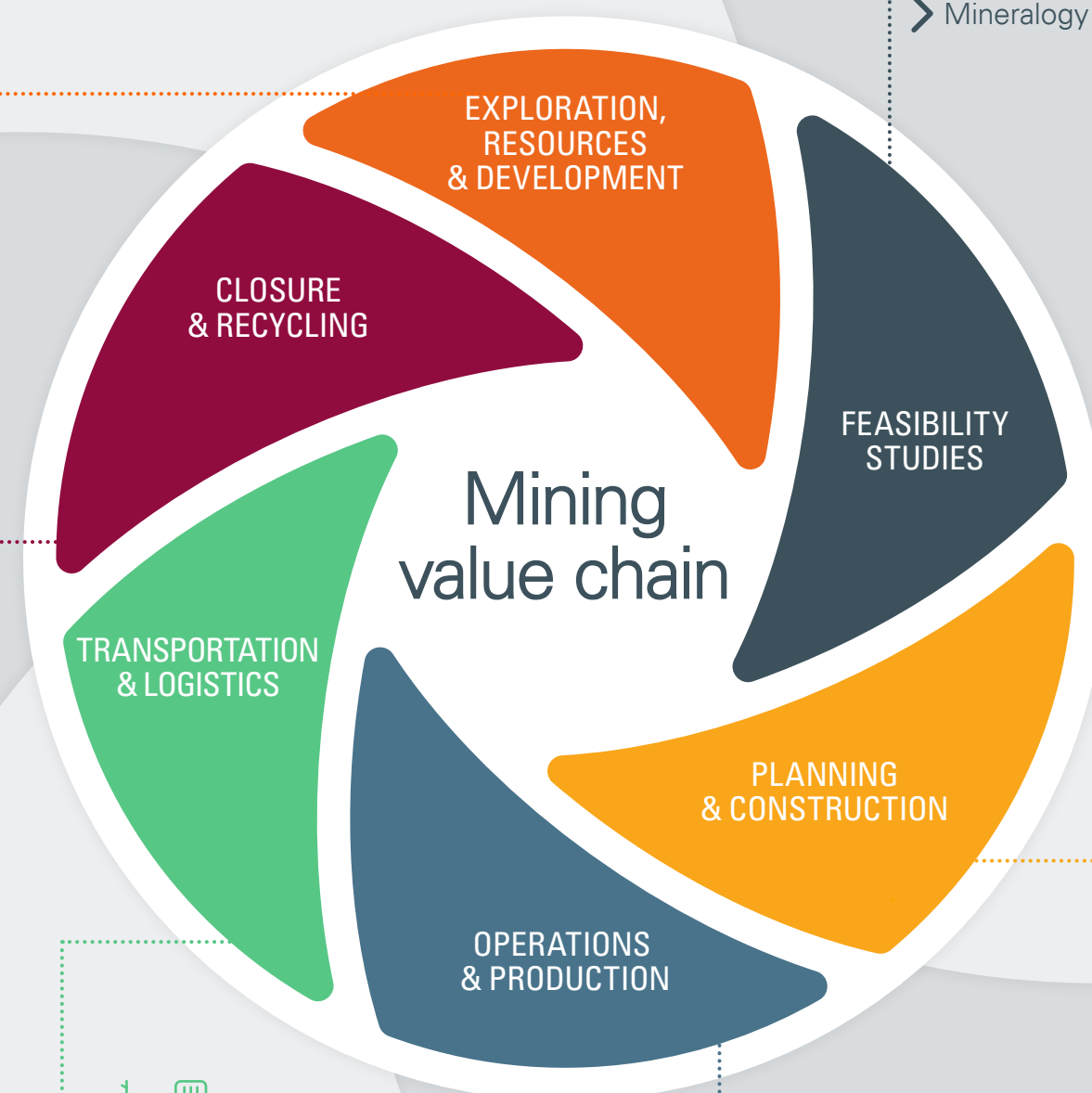
- > Engineering
- > Procurement
- > Construction management



- > Trade analysis
- > Loading & discharge
- > Supply chain risk management



- > Geometallurgy
- > Advanced process control
- > On-site laboratories & optimization





## A Trusted Partner

SGS's Centres of Excellence and major regional laboratories conform to the requirements of the ISO/IEC 17025 standard for specific tests as per the published scopes of accreditation. SGS provides analytical services for every stage of your project including:

- Exploration
- Developmental Studies
- Mine Production
- Shipment
- Trade
- Mine Closure

### Analytical Methods and Limits

There are several distinct stages in the evaluation of a project – from a grassroots exploration (early stage) to the final stages of process/grade control at mine development and operation. At each stage, the analytical technique should be carefully considered

with respect to the needs of the program. For example, grassroots exploration generally requires methods based on a partial or weak extraction followed by multi-element analysis. In contrast, analyzes for a feasibility stage program generally involve a complete digestion followed by the analysis of a specific elemental suite focused on pay and penalty elements.

In the early stages of exploration, precision at low concentrations, sensitivity and cost effectiveness are usually key when defining an anomaly. Accuracy might not be as important as the ability of the method to reproduce and detect subtle anomalies above background or threshold levels. A partial or weak extraction method that is followed by multi-element scans could be acceptable at this stage.

In process or grade control situations, both accuracy and precision are critical. A total dissolution of the sample followed by the analysis of specific elements is more appropriate. Commercial transaction assays require highly precise and accurate assays

involving classical methodology. In mineral analysis, the concept and application of detection limit is not defined universally nor is it governed by a regulated policy. The terminology used to describe this concept is varied, misused and often confusing. The lower limit (detection limit) is frequently used to market method capabilities but depending upon how this limit is validated and tested, this limit can be misleading. It is important when selecting a method, that all factors are considered.

- What are the elements of interest and their concentration range?
- What is the required precision at or near the concentration of the analyte of interest?
- What is the mineral composition or source of my samples and will this affect the detection limit for the elements of interest?

Method choice should not be exclusively selected based on the lower limit or without consideration of the points above. Limits must be well defined and established using rigorous studies that involve matrix equivalent samples taken through the entire method process and not simply by using a reagent or water blank. Statistical analysis must be used both to estimate and test the lower limit at a suitable confidence level. At SGS, our laboratories take pride in our determination of method/analyte specific limits to ensure that this limit can be confidently projected across a wide range of samples and is fit for purpose.

There are many different analytical methods available in the industry. More detailed descriptions of the common analytes, grades and methods follow in this guide and can help you with method selection. A more exhaustive list of methods is available at your local laboratory. An SGS professional is always available to assist you with analytical technique selection. Contact [naturalresources@sgs.com](mailto:naturalresources@sgs.com)

### Electronic Data Availability and Reporting

Our “QLab” <https://qlab.sgs.com> tool provides our clients with the ability to track the status of their samples and access the immediate and secure retrieval of analytical data. The information available includes the job status, turn-around time, scheme/ method, client-specific quality control data and the results of your analyzes. All results are reported electronically immediately upon completion. Reporting units can be specified as ppb, ppm, g/t, % or oz/tonne (as applicable). If required, a hardcopy can be provided, but a fee may be charged. Copies of all certificates and invoices are sent via PDF email to the address you specify.

### Data Turnaround

Samples are processed at each SGS laboratory as promptly as possible. Sample batches requiring turnaround commitments outside contractual arrangements should be discussed with the appropriate laboratory customer services personnel.





## On-site & Commercial Testing Laboratory



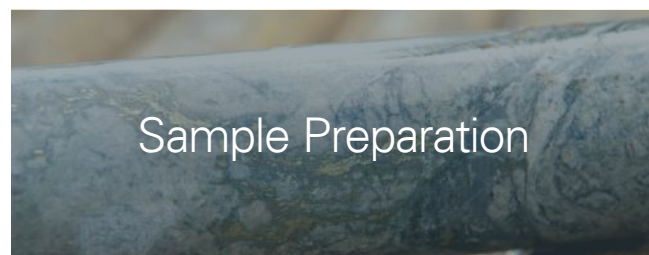
On-site & Commercial Testing Laboratory



Use data insights to make informed decisions



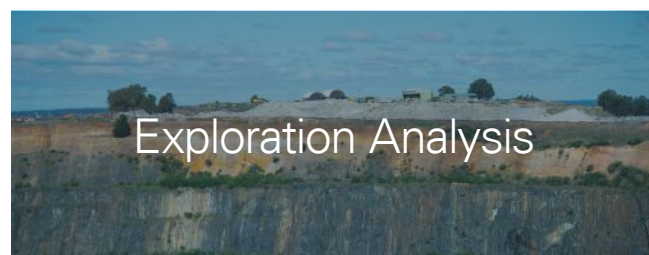
Sample Administration



Sample Preparation



Precious Metals Analysis



Exploration Analysis

## Customized laboratory operations at your site

Efficient and financially viable mining operations require accurate and reliable data to help managers optimize their processes and ensure contractual and regulatory compliance.

With a global network of specialists, we are ready to help support you with advanced on-site geochemical analysis. From exploration to operation, our on-site teams provide data that will help you gain the high-level insights you need to make informed operational decisions. Our services allow you to fine-tune every stage of your value chain with solutions that support exploration, mining, mill and plant operations, smelting, and tailings disposal.

Gain flexibility and a competitive edge when you use our on-site or mobile laboratory services:

- Benefit from fast turnaround and accurate data
- Avoid project delays and reduce shipping delays
- Focus on the core aspects of your operation and allocate resources more effectively
- Take advantage of our technical expertise and experience in real-time

Our on-site laboratories give you access to trusted, third-party analysis – no matter how remote the location is.





## Use data insights to make informed decisions

Commercial viability for your mining operation requires detailed characterization of your ore body and optimized mineral processing.

We provide a wide range of analytical methods to help you quantify your mineral resource and check extraction processes – from grade control for minimizing dilution during mining to process control in the plant. This insight helps you make informed decisions about your project and communicate with lenders, investors and other important stakeholders.

With a global network of specialists, backed by state-of-the-art testing facilities, we provide you with valuable data at various stages of your mining project. Our experts perform high quality, multi-element analyzes that target a wide variety of elements in many types of sample matrices.

Our range of analytical tools support you in the discovery phase, using feasibility studies, and during operations, to ensure you have the right systems in place to improve recovery and properly monitor tailings and waste rock.

SGS is recognized as the global benchmark for quality and integrity. Wherever you operate in the world, our industry-recognized experts are available to help you make informed decisions that optimize your operation.

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From sample preparation to exploration, ore- and control-grade analysis, we offer tailored packages and custom service offerings to meet all your unique needs.





# Sample Administration

## Sample submittal, collection and pick up

Samples can be submitted to the nearest SGS laboratory or sample preparation facility outlined on your proposal or quote received from SGS. When your samples are transported to SGS by a third party, please send notice of shipment dispatch directly to the SGS receiving laboratory. Please record the name of the freight company, date of dispatch, waybill numbers, number of pieces and number of samples. This ensures that we can track and plan for your shipment.

We strongly recommend that all sample submissions be clearly labelled. Sample submissions that are poorly labelled or packaged can incur additional sorting charges.

All sample shipments require a completed sample submittal form or letter with clear and complete instructions to avoid delays. Sample submission forms can be found on

our website at [sgs.com/geochemistry](https://www.sgs.com/geochemistry). Samples will be on hold for analysis until we have complete instructions.

The minimum information required to proceed is:

- Company name and complete address
- Contact name
- Details for distribution of reports and invoices
- Method codes
- Instructions on sample preparation
- List or range of sample numbers
- Sample Fate (remove disposal / return / or storage) requirements
- Unusual sample characteristics
- Warning if any samples are potentially hazardous/ additional MSDS

### Some tips

To eliminate customs delays, please include the following information:

- Description of goods, such as "Geological sample for testing purposes only"
- The receiving SGS laboratory will have the required customs or quarantine certification to receive your submission promptly. Please contact the laboratory so we can provide the permit details that must be included with the transport documents prior to dispatch
- Some national authorities require prior notification before samples can be received by certified laboratories. This includes NORM samples and International Soil Samples. SGS will facilitate this to avoid unnecessary delays in sample receipt

Please **contact** the Customer Service representative for your region for more information and advice on selecting the method and application for your project. Together, we can eliminate unnecessary delays and costs by following these sample submission protocols.

CODE	ANALYTE CODE	DESCRIPTION
G_PKP		Sample collection/pickup
G_LOG		Sample sorting and registration
G_WGH_KG	WTKG	Sample weight as received
G_WGH_KG	DRYWTKG	Sample weight after drying
G_WGH_KG	BULWTIN	Bullion weight received
G_WGH_KG	BULWTOUT	Bullion weight after analysis





Sample tracking

All SGS laboratories run sophisticated LIMS systems, which facilitates complete tracking of analyses throughout the laboratory. It directly tracks all samples from the time they are received at the preparation facility until they are sent to a SGS Centre of Excellence, analyzed and reported. For more information about this process, please ask your local SGS laboratory.



Sample return, retention, storage and disposal

SGS laboratory staff will discuss sample management with each client on an individual basis. Samples may be kept on-site for a maximum of three months, after which storage fees may apply. Please contact your SGS client services representative for more information about our sample return, retention, storage and disposal services and policies.

CODE	ANALYTE CODE	DESCRIPTION
G_DISP	RTN01	Return, pulp/rejects to client
G_RTV_HR		Retrieval and handling of samples for reanalysis
G_STORE	STO01	Store, cage, monthly rate
G_STORE	STO02	Store, bulka bag, monthly rate
G_STORE	STO03	Store, crate, monthly rate
G_STORE	STO04	Store, pallet, monthly rate
G_STORE	STO05	Retain coarse project
G_STORE	STO06	Retain pulp residue
G_STAMP_DISP		Sample/Waste disposal fee
G_DISP	DISP10	Disposal via pallet, includes transfer of samples
G_DISP	DISP11	Disposal via skip, includes transfer of samples
G_DISP	DISP12	Disposal via steel cage, includes transfer of samples
G_DISP	DISP13	Disposal via bulka bag, includes transfer of samples
G_DISP	DISP14	Disposal of sample material, per kg rate
G_DISP	DISP15	Disposal of samples, incineration (soils)
G_DISP	DISP16	Disposal of pulp samples (packets)





# Sample Preparation

Sample preparation (also referred to as sample reduction) is the process by which a sample is crushed and pulverized for analysis. This will almost always involve sub-sampling. The right sampling method will produce a sub-sample that is representative of the total sample. Good sample reduction practice is essential to obtaining meaningful and reliable analytical data. SGS is committed to providing dedicated sample preparation procedures at each of our locations. This involves technologically advanced equipment and, in most cases, physically separated sample processing areas for each sample type.

The crushing and pulverizing options available are varied. Your choice can depend on the sample type and the mineral that hosts the element of interest within the sample matrix. Please consult with our technical personnel for the best possible option for your samples before starting an analytical program.

During sample reduction, there are many critical points where sample contamination can occur. One such area arises from the type of equipment used. Unfortunately, during sample reduction, contamination can never be avoided but processes are utilized to keep the level of contamination to a minimum. The levels are dependent on sample hardness, crushing and pulverizing time as well as crushing / grinding media used. Contamination levels can be measured and the table below indicates the type of levels of possible contamination from a variety of grinding media.

## Bowl Selection

BOWL TYPE	SAMPLE CAPACITY	MAIN CONTAMINANT	MINOR CONTAMINANT
Standard mild steel bowl	To 3 kg	Fe, Cr	Mo
Cr-free steel	500 g to 1.5 kg	Fe	Mn
Zirconia	100 g	Zr, Hf	Al
Tungsten carbide	150 g	W, Co	Ta
Agate	100 g		Si

Note: Not all pulverizing bowl types are available at all locations. Please enquire.

## Sample Preparation Procedures

### SPLITTING

CODE	ANALYTE CODE	DESCRIPTION
G_SPL	SPL_RF	Manual Riffle Splitting
G_SPL	SPL_CQ	Cone and Quarter Splitting
G_SPL	SPL_X	Split additional representative samples
G_SPL	SPL_RO	Rotary Split <3 kg
G_SPL	SPL_RO_M	Rotary Split, Micro Split <100 g

### DRYING

CODE	ANALYTE CODE	DESCRIPTION
G_DRY	DRY105	Sample Drying, 105°C, <3 kg
G_DRY	MICRO_105	Microwave Sample Drying, 105°C, <3 kg
G_DRY	DRY60	Sample Drying, 60°C, <3 kg
G_DRY	DRY_AIR	Sample Drying, Room Temp, <3 kg
G_DRY_KG	DRY_XT_WT	Sample Drying, Excessively Wet Samples
G_DRY_KG	DRY_C	Oven Drying, 105°C, Carbon Samples

Note: If you require additional weight options, please contact your SGS representative for more information.







CRUSHING

CODE	ANALYTE CODE	DESCRIPTION
G_CRU	CRU3	Coarse crush 3.36 mm
G_CRU	CRU6	Coarse crush 6 mm
G_CRU	CRU75	Crush <3 kg, 75% passing 2 mm
G_CRU_KG	CRU75_WT	Crush >3kg, per kg, 75% passing 2 mm
G_CRU	CRU90	Crush <3 kg, 90% passing 2 mm
G_CRU_KG	CRU90_WT	Crush >3 kg, per kg, 90% passing 2 mm
G_PUL	PUL_CRM	CRM Pulverize <3 kg, 90% passing 1 mm
G_PUL	PUL_CRM_KG	CRM Pulverize >3 kg, per kg, 90% passing 1 mm

SCREENING

CODE	ANALYTE CODE	DESCRIPTION
G_SCR_D	SOIL_WT	Dry Screening to -80mesh (180µm), per kg
G_SCR_D	G_SCR_KG	Dry Screening, various micron particle sizes, per kg
G_SCR_W	G_SCR_KG	Wet Screening, various micron particle sizes, per kg
G_MET	CYC01	Cyclosizing
G_FAS	SCR75	Metallic/Screening Procedure 75 µm
G_FAS	SCR106	Metallic/Screening Procedure 106 µm
G_FAS	SCR212	Metallic/Screening Procedure 212 µm
G_SCR	SCR21	Wet Screening Desliming, various micron particle sizes per kg

PULVERIZING

CODE	ANALYTE CODE	DESCRIPTION
G_PUL	PUL85_CR	Pulv, Cr Steel, 85% 75µm 250g
G_PUL	PUL85_CR1000	Pulv, Cr Steel, 85% 75µm 1000g
G_PUL	PUL85_CR3000	Pulv, Cr Steel, 85% 75µm 3000g
G_PUL	PUL90_CR250	Pulv, Cr Steel, 90% 75µm 250g
G_PUL	PUL90_CR1000	Pulv, Cr Steel, 90% 75µm 1000g
G_PUL	PUL90_CR3000	Pulv, Cr Steel, 90% 75µm 3000g
G_PUL	PUL85_ZR	Pulv, Zirconia bowl, 50-80g
G_PUL	PUL85_W	Pulv, Tungsten Carbide Bowl <100g
G_PUL	PUL85_A	Pulv, Agate/Ceramic Mort & Pest <100g
G_PUL	PUL85_A_RING	Pulv, Agate/Ceramic Ringmill <100g
G_PUL	GRD106_A	Disc Grind, 106µm 500g-1.5kg
G_PUL	GRD106_B	Disc Grind, 106µm 1.5kg-3.5kg
G_PUL	PUL_R	Ringmill Preparation, Carbon Sample(s)
G_PUL	PUL_H	Hand Preparation, Carbon Sample(s)
G_PUL	PUL_CON	Pulverization of Concentrates

Note: If you require additional weight options, please contact your SGS representative for more information. Samples can also be pulverized at customer specified grain sizes (i.e. 106 or 120 microns) and % passing requirements. Please enquire.





Miscellaneous Procedures

CODE	ANALYTE CODE	DESCRIPTION
G_WSH	G_WSH_CRU	Barren wash after crushing stage
G_WSH	G_WSH_PUL	Barren wash after pulverizing stage
G_PRP	PRP_COM	Compositing samples
G_RAD		Radiation monitoring using scintillation counter
G_PRP	PRP_EN	Radioactive preparation environment
G_PRP	PRP_EN2	Asbestos preparation environment
G_QRT		Sample quarantine and handling

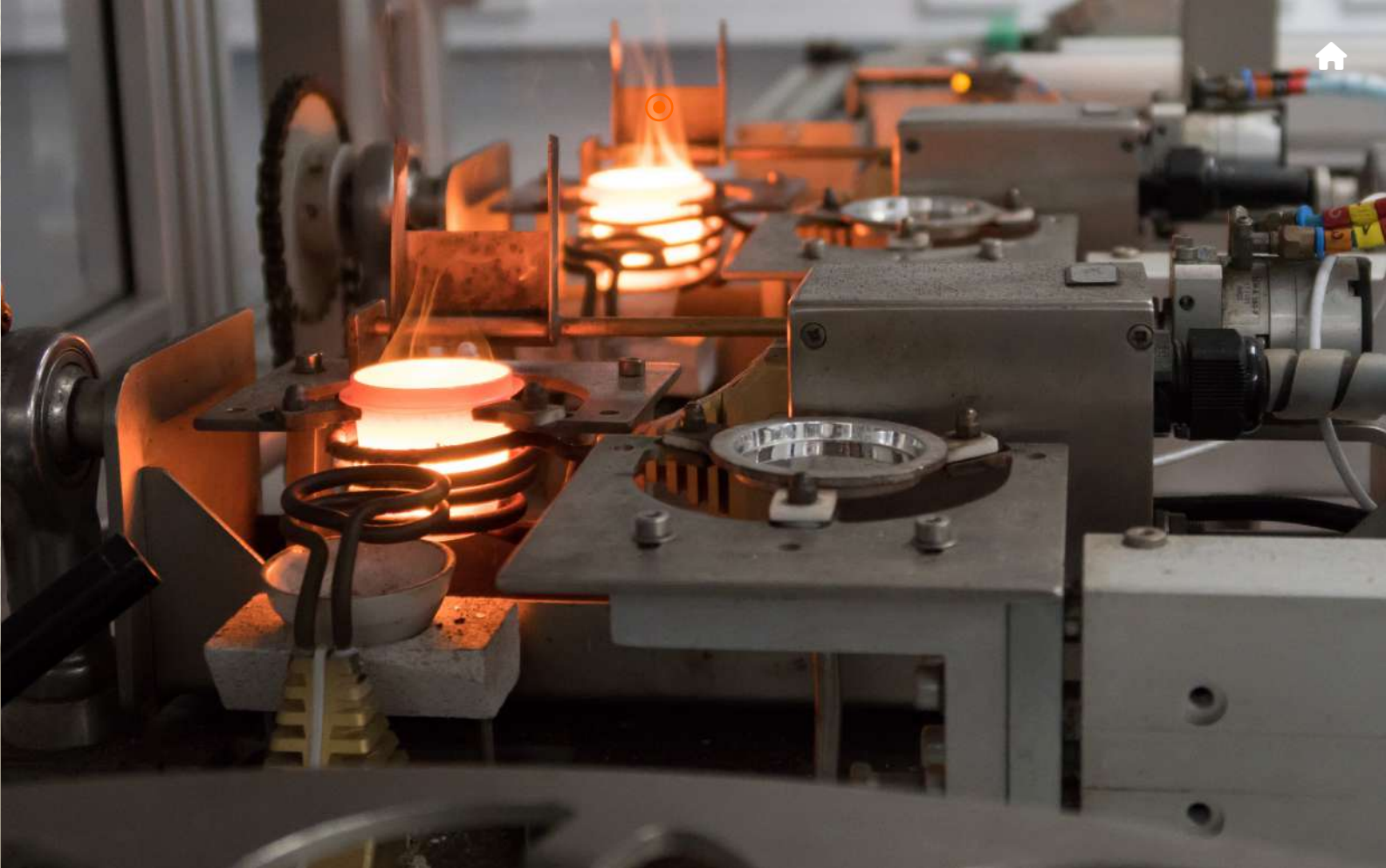
Moisture and Loss on Ignition (LOI)

Many materials contain volatile components and/or moisture. SGS has a variety of tests, including moisture (H<sub>2</sub>O), loss on ignition (LOI) (at various temperatures) and thermogravimetric analysis (TGA), that provide reliable and quantitative analyses of these parameters.

MOISTURE (H <sub>2</sub> O)			
CODE	ELEMENT	LIMIT(S)	DESCRIPTION
G_PHY03V	H <sub>2</sub> O-	≥ 0.1 %	Bulk, Gravimetric determination at 105°C
G_PHY04V	H <sub>2</sub> O-	≥ 0.01 %	Pulp, Gravimetric determination at 105°C
G_PHY05V	H <sub>2</sub> O-	≥ 0.1 %	Penfield tube

LOSS ON IGNITION (LOI)			
CODE	ELEMENT	LIMIT(S)	DESCRIPTION
G_PHY01V	LOI	-10 - 100 %	Gravimetric determination at 1000°C
G_PHY02V	LOI	-50 - 100 %	Multi-point TGA determinations

Note: Moisture and LOI can be determined at other temperatures. Please enquire.



Specific Gravity and Bulk Density

Density is a fundamental rock property and can be defined a number of different ways. At SGS, we determine the specific gravity (SG) and bulk density (BD) of rocks, ores and aggregates. Specific gravity is the density of a material relative to water or air and is expressed as a dimensionless number. It is normally measured by the gas pycnometer method on pulp samples and amounts to the average SG of the mineral particles making up the rock or ore. It is an important parameter when developing metallurgical flowsheets or calculating the exact weight of a concentrate being shipped or stored. Density profiles of ores for dense media separation can be measured using heavy liquids.

Bulk density is the average SG of the minerals comprising a rock plus the void space (from vugs, pores, etc.) and is measured by the water immersion method on fist sized rock samples or core. Samples are waxed if there is significant porosity. If the rock samples are competent waxing may not be necessary.

Bulk density along with grade and volume is an extremely important parameter in calculating tonnages for Mineral Resource estimates or ore reserves, which are critical for economic evaluation of mineral deposits. Inadequate BD measurements are often at the root of errors in ore estimates with financial consequences for projects.

Use high quality specific gravity, bulk density and grain size physical property data from SGS for robust Resource Estimate calculations and in developing mineral processing flow sheets.

G_PHY06V	Specific gravity - pycnometer
G_PHY08V	Specific gravity - volumetric
G_PHY17V	Bulk density - immersion, waxed
G_PHY18V	Bulk density - immersion, non-waxed

Particle Size Analysis

Particle size analysis is used to determine the size classification of tills, sediments or ores or to produce sized fractions for additional testing/analysis. SGS offers particle size analysis by wet screening, dry screening, a combination of both, or laser diffraction.

Wet screening is preferable to dry screening for materials containing a high percentage of clays which tend to agglomerate and thus give erroneous dry screening results. Dry screen tests can be performed on a variety of materials, but the sample must be free flowing and the particles separated (i.e. unagglomerated).

Often wet and dry methods are combined. Wet screening is performed to remove excessive fines then dry screening is performed to remove the oversize. Depending upon the nature of the material, dry screening, wet screening or a combination of both can be used.

Laser diffraction is recommended for very fine grained samples, as it is capable of measuring particle sizes at very low limits (0.02 microns). Laser diffraction is suitable for use with both wet and dry samples.

G_PHY15V	Particle size, sieve analysis (dry or wet)
G_PHY16V	Particle size, laser diffraction





## FOCUS ON

# A wide range of independent quality and quantification services for a variety of metals and minerals

You operate globally, optimizing production and operations from all around the world. Our global network of experts will be your trusted partner, meeting your analytical requirements.

Through our global network of laboratories, our experts offer a variety of instrumental and classical techniques to ensure accurate assays. We will help you select a method that is best for your sample type to ensure you get the data you need.

Our experts are experienced in:

- Precious and base metals
- Critical and battery metals
- Industrial minerals
- Bulk commodities

Whatever the commodity, wherever the location, our trusted professionals will be with you every step of the way.

## Precious Metals Analysis

Precious metals (gold, silver and the platinum group elements) can be analyzed and assayed by many techniques. Coupled with the many sample preparation options to ensure representative samples SGS sets the benchmark for reliable precious metal assays.

Note: Lower and upper reporting limits of a given method can vary slightly among SGS laboratories due to reagent quality, access to consumables and instrument availability. Please enquire.

### Gold

#### EXPLORATION GRADE ANALYSIS

##### FIRE ASSAY GOLD

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GE_FAA30V5	Au	5 - 10,000 ppb	30 g, Fire assay, AAS finish
GE_FAA50V5	Au	5 - 10,000 ppb	50 g, Fire assay, AAS finish
GE_FAI30V5*	Au**	1 - 10,000 ppb	30 g, Fire assay, ICP-OES finish
GE_FAI50V5*	Au**	1 - 10,000 ppb	50 g, Fire assay, ICP-OES finish
GE_FAI31V5	Au**	5 - 10,000 ppb	30 g, Fire assay, ICP-OES finish
GE_FAI51V5	Au**	5 - 10,000 ppb	50 g, Fire assay, ICP-OES finish
GE_FAM30V5	Au**	1 - 2,000 ppb	30 g, Fire assay, ICP-MS finish
GE_FAM50V5	Au**	1 - 2,000 ppb	50 g, Fire assay, ICP-MS finish

Note: \*GE\_FAI30V5/GE\_FAI50V5 methods use new fire assay pots to achieve these lower limits.

\*\* Pt and Pd can be included.

Gold in soils and/or sediments can be determined by aqua regia digest and DIBK extraction. This is a partial leach and can require a pre-treatment such as roasting if samples contain significant sulphur bearing phases.





GOLD BY ACID DIGESTION (AQUA REGIA)

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GE_ARE1V50	Au	1 - 800 ppb	50 g, Aqua regia digest, DIBK extraction, AAS finish
GE_ARE2V25	Au	0.01 - 100 ppm	25 g, Aqua regia digest, DIBK extraction, AAS finish
GE_ARE2V50	Au	0.01 - 100 ppm	50 g, Aqua regia digest, DIBK extraction, AAS finish
GE_ARMV25	Au*	1 - 500 ppb	25 g, Aqua regia digest, ICP-MS finish
GE_ARMV50	Au*	1 - 500 ppb	50 g, Aqua regia digest, ICP-MS finish

Note: \*Additional elements are available on request

Cyanide leach procedures are used to enhance small gold anomalies during exploration and to monitor gold extraction efficiencies in metallurgical applications.

Bulk Leach Extractable Gold (BLEG) is a cyanide-based partial leach procedure that uses a large sample size (0.5 kg to 5 kg). It is used to enhance small gold anomalies during exploration. The cyanide leachate solution is extracted into an organic solvent and analyzed. Our active cyanide leach packages are available with a variety of sample sizes, detection limits and finishing methods. The mini cyanide leach package is available for smaller sample sizes, allowing for faster TAT than active cyanide leach.

Other elements are also partially extracted with the cyanide leach and can be measured on request.

CYANIDE EXTRACTABLE GOLD

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GE_MBLA65V30	Au	0.03 - 100 ppm	Hot, 30 g, Mini cyanide leach, AAS finish
GE_BLE61K	Au	0.01 - 100 ppm	500 g, Active cyanide leach, Solvent extraction, AAS finish
GE_BLE61NL	Au	1 - 10,000 ppb	2000 g, Active cyanide leach, Solvent extraction, AAS finish

The Leachwell™ tab is a proprietary product and Leachwell™ is a patented process. Accelerated cyanide leach techniques are used to determine bulk leachable gold in exploration samples using modified cyanide leach (Leachwell™). The large sample is mixed with water and Leachwell™ tabs and tumbled. The gold is extracted into DIBK and analyzed. Other elements (Cu, Ag, Pb and Zn) are also partially extracted by the cyanide leach and can be measured on request.

ACCELERATED CYANIDE LEACH FOR GOLD

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GE_LWE69J	Au	0.01 - 1,000 ppm	200 g, Accelerated cyanide leach, AAS finish
GE_LWE69K	Au	0.01 - 1,000 ppm	500 g, Accelerated cyanide leach, AAS finish
GE_LWE69L	Au	0.01 - 1,000 ppm	800 g, Accelerated cyanide leach, AAS finish
GE_LWE69M	Au	0.01 - 1,000 ppm	1000 g, Accelerated cyanide leach, AAS finish
GE_LWE69N	Au	0.01 - 1,000 ppm	2000 g, Accelerated cyanide leach, AAS finish

Note: These methods are also available with ICP-MS finish

ORE-GRADE ANALYSIS

INSTRUMENTAL AND GRAVIMETRIC ANALYSIS

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GO_FAA30V10	Au	0.01 - 100 ppm	30 g, Fire assay, AAS finish
GO_FAA50V10	Au	0.01 - 100 ppm	50 g, Fire assay, AAS finish
GO_FAP30V10	Au	0.01 - 100 ppm	30 g, Fire assay, MP-AES finish
GO_FAP50V10	Au	0.01 - 100 ppm	50 g, Fire assay, MP-AES finish
GO_FAI30V10	Au **	0.01 - 100 ppm	30 g, Fire assay, ICP-OES finish
GO_FAI50V10	Au **	0.01 - 100 ppm	50 g, Fire assay, ICP-OES finish
GO_FAG30V	Au	0.5 - 10,000 ppm	30 g, Fire assay, gravimetric finish
GO_FAG50V	Au	0.5 - 10,000 ppm	50 g, Fire assay, gravimetric finish
GO_FAG32V	Au	0.01 - 100 ppm	30 g, Fire assay, AAS finish (Au) gravimetric finish (Ag)
	Ag	10 - 10,000 ppm	
GO_FAG52V	Au	0.01 - 100 ppm	50 g, Fire assay, AAS finish (Au) gravimetric finish (Ag)
	Ag	10 - 10,000 ppm	
GO_FAG33V	Au	0.5 - 10,000 ppm	30 g, Fire assay, gravimetric finish (Au, Ag)
	Ag	10 - 10,000 ppm	

\*\* Pt and Pd can be included.

SCREEN METALLIC GOLD ANALYSIS

Analytical results can be difficult to reproduce using typical sample reduction and fire assay procedures when coarse grained metallic gold is present. To address this, the sample can be analyzed using the screened metallics sample preparation and assaying procedure.



This consists of:

- Screening 500g/1000g or client specified weight of the sample to a defined grain size, typically 75, 106 or 200 microns.
- Weighing the various fractions.
- Assaying the entire plus fraction.
- Weighing and analyzing the undersize (typically in duplicate).

- Calculating and reporting of size-fraction weights, coarse and fine fraction gold content and total gold content.
- The finish technique may involve AAS, ICP-OES or gravimetric, depending upon concentration. Limits shown are based on instrument analysis. Gravimetric limits are higher, please contact us for more information.

Note: This technique requires a minimum sample of 500g. This technique can also be used for coarse grained native metals such as platinum, palladium, silver and copper.

SCREENED METALLICS

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GO_FAS30K	Au	≥ 0.01 ppm	Au, Ag, screen metallics* (75/106/212), 30 g. Fire assay
	Ag	≥ 10 ppm	AAS/ICP/Gray, 500g
GO_FAS50K	Au	≥ 0.01 ppm	Au, Ag, screen metallics* (75/106/212), 50 g. Fire assay
	Ag	≥ 10 ppm	AAS/ICP/Gray, 500g
GO_FAS30M	Au	≥ 0.01 ppm	Au, Ag, screen metallics* (75/106/212), 30 g. Fire assay
	Ag	≥ 10 ppm	AAS/ICP/Gray, 1000g
GO_FAS50M	Au	≥ 0.01 ppm	Au, Ag, screen metallics* (75/106/212), 50 g. Fire assay
	Ag	≥ 10 ppm	AAS/ICP/Gray, 1000g
GO_FAS30V	Au	≥ 0.01 ppm	Au, Ag, screen metallics* (75/106/212), 30 g. Fire assay
	Ag	≥ 10 ppm	AAS/ICP/Gray, >1000g
GO_FAS50V	Au	≥ 0.01 ppm	Au, Ag, screen metallics* (75/106/212), 50 g. Fire assay
	Ag	≥ 10 ppm	AAS/ICP/Gray, >1000g

Note: \*options for screen sizes available. Pt, Pd can be added. Finish technique is based on concentration.

CONTROL AND CONCENTRATE-GRADE ANALYSIS

INSTRUMENTAL AND GRAVIMETRIC ANALYSIS

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GC_FAA30V10	Au	0.01 - 1,000 ppm	30 g, Fire assay, AAS finish
GC_FAA50V10	Au	0.01 - 1,000 ppm	50 g, Fire assay, AAS finish
GC_FAG32V	Au	0.01 - 1,000 ppm	30 g, Fire assay, AAS finish (Au)
	Ag	≥ 10 ppm	30 g, Fire assay, gravimetric finish (Ag)
GC_FAG33V	Au	≥ 0.5 ppm	30 g, Fire assay, gravimetric finish (Au)
	Ag	≥ 10 ppm	30 g, Fire assay, gravimetric finish (Ag)

GOLD IN PROCESS SOLUTIONS

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GC_FSA84T	Au	≥ 0.01 mg/L	Solution, Fire assay, AAS finish
GC_FSI84T*	Au	≥ 0.01 mg/L	Solution, Fire assay, ICP-OES finish

Note: These methods are also applicable to cyanide liquors. Pt, Pd can be added. \* The Pt and Pd can only be added for GC\_FSI84T

GOLD IN CYANIDE LIQUORS

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GC_AAS82T	Au	≥ 0.05 mg/L	CN solution, AAS finish
GC_AAS82X	Au	≥ 0.001 mg/L	Solvent extraction, DIBK, AAS finish

GOLD IN CARBON

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GC_FAA01V100	Au	5 - 20,000 ppm	1 - 2 g, Fire assay, AAS finish
	Ag	≥ 50 ppm	1 - 2 g Fire Assay, gravimetric finish
GC_ACA22D100V	Au	5 - 250,000 ppm	1 g, Ash, acid digest, AAS finish
GC_FAG01V	Au	≥ 7.5 ppm	1 - 2 g, Fire assay, gravimetric finish
	Ag	≥ 50 ppm	1 - 2 g Fire Assay, gravimetric finish

GOLD BULLION

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GC_BUL36V	Au	0.5 - 99.5%	100 - 500 mg, Fire assay, gravimetric finish
	Ag	0.01 - 99.5%	100 - 500 mg, Fire assay, gravimetric finish





Silver

EXPLORATION GRADE ANALYSIS

ACID DIGESTION - INSTRUMENTATION

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GE_AAS22E50	Ag	0.3 - 100 ppm	2 g, 2-Acid digest, AAS finish
GE_AAS33E50	Ag	0.3 - 100 ppm	2 g, 3-Acid digest, AAS finish
GE_AAS42E50	Ag	0.3 - 100 ppm	2 g, 4-Acid digest, AAS finish

Note: It is recommended that mineralized samples with Ag >30 ppm are analyzed using the GO\_AAS21C50 method below. Silver (Ag) can also be analyzed in many multi-element packages.

ORE-GRADE ANALYSIS

ACID DIGESTION - INSTRUMENTATION

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GO_AAS21C50	Ag	1 - 300 ppm	0.5 g, 2-Acid digest, AAS finish

GRAVIMETRIC ANALYSIS

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GO_FAG32V	Au	0.01 - 100 ppm	30 g, Fire assay, AAS finish (Au) gravimetric finish (Ag)
	Ag	10 - 10,000 ppm	
GO_FAG33V	Au	0.5 - 10,000 ppm	30 g, Fire assay, gravimetric finish (Au, Ag)
	Ag	10 - 10,000 ppm	
GO_FAG52V	Au	0.01 - 100 ppm	50 g, Fire assay, AAS finish (Au), gravimetric finish (Ag)
	Ag	10 - 10000 ppm	

CONTROL AND CONCENTRATE-GRADE ANALYSIS

INSTRUMENTAL AND GRAVIMETRIC ANALYSIS

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GC_AAS43V100	Ag	1 - 1,000 ppm	Variable wt, 4-acid digest, AAS finish
GC_FAG32V	Au	0.01 - 1,000 ppm	30 g, Fire assay, AAS finish (Au) gravimetric finish (Ag)
	Ag	≥ 10 ppm	
GC_FAG33V	Au	≥ 0.5 ppm	30 g, Fire assay, gravimetric finish (Au, Ag)
	Ag	≥ 10 ppm	
GC_ACA22D100V	Ag	2 - 2,000 ppm	Carbon, 1 g, ash, acid digest, extract, AAS finish
GC_BUL36V	Ag	0.01 - 99.5%	100-500 mg, Fire assay, gravimetric finish





Gold, Platinum, Palladium and Other Precious Metals

EXPLORATION GRADE ANALYSIS  
GOLD, PLATINUM AND PALLADIUM

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GE_FAI30V5*	Au	1 - 10,000 ppb	30 g, Fire assay, ICP-OES finish
	Pt	10 - 10,000 ppb	
	Pd	1 - 10,000 ppb	
GE_FAI50V5*	Au	1 - 10,000 ppb	50 g, Fire assay, ICP-OES finish
	Pt	10 - 10,000 ppb	
	Pd	1 - 10,000 ppb	
GE_FAM30V5	Au	1 - 2,000 ppb	30 g, Fire assay, ICP-MS finish
	Pt	0.5 - 2,000 ppb	
	Pd	0.5 - 2,000 ppb	
GE_FAM50V5	Au	1 - 2,000 ppb	50 g, Fire assay, ICP-MS finish
	Pt	0.5 - 2,000 ppb	
	Pd	0.5 - 2,000 ppb	
GE_FAI31V5	Au	5 - 10,000 ppb	30 g, Fire assay, ICP-OES finish
	Pt	10 - 10,000 ppb	
	Pd	5 - 10,000 ppb	
GE_FAI51V5	Au	5 - 10,000 ppb	50 g, Fire assay, ICP-OES finish
	Pt	10 - 10,000 ppb	
	Pd	5 - 10,000 ppb	

Note: \*GE\_FAI30V5 & GE\_FAI50V5 methods use new fire assay pots to achieve lower limits.

ORE-GRADE ANALYSIS  
GOLD, PLATINUM AND PALLADIUM

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GO_FAI30V10	Au	0.01 - 100 ppm	30 g, Fire assay, ICP-OES finish
	Pt	0.01 - 100 ppm	
	Pd	0.01 - 100 ppm	
GO_FAI50V10	Au	0.01 - 100 ppm	50 g, Fire assay, ICP-OES finish
	Pt	0.01 - 100 ppm	
	Pd	0.01 - 100 ppm	

CONTROL-GRADE ANALYSIS  
GOLD, PLATINUM AND PALLADIUM

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GC_FAI35V10	Au	0.02 ppm - 20%	Variable wt, Fire assay, ICP-OES finish
	Pt	0.02 ppm - 20%	
	Pd	0.02 ppm - 20%	
GC_FAA35V10	Au	0.02 ppm - 20%	Variable wt, Fire assay, AAS finish
	Pt	0.02 ppm - 20%	
	Pd	0.02 ppm - 20%	

PLATINUM GROUP ELEMENTS

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GC_FAI41V10	Au	≥ 0.02 ppm	30 g, Fire assay nickel sulphide collection, ICP-OES
	Pt	≥ 0.02 ppm	
	Pd	≥ 0.02 ppm	
	Rh	≥ 0.02 ppm	
	Ru	≥ 0.05 ppm	
	Ir	≥ 0.13 ppm	

This method is not available in all SGS laboratories; please contact us for more information.

CODE	ELEMENT	LIMITS	DESCRIPTION
GC_FAM42V10	Pt	0.02 ppm	30 g, Fire assay nickel sulphide collection, ICP-MS
	Pd	0.02 ppm	
	Rh	0.02 ppm	
	Ru	0.05 ppm	
	Ir	0.02 ppm	

Note: This method is not available in all SGS laboratories. Samples can be analyzed for Osmium by neutron activation. Please contact us for more information.





# Exploration Analysis

Our global services provides a range of geochemical methods for finding and characterizing mineral deposits of every type. Finding economically viable mineral deposits requires an expert understanding of the geochemical signatures and footprints of potential ore bodies.

We lead the way in providing fit for purpose exploration geochemical analysis solutions that support exploration programs around the world. Utilizing a range of effective and proven methods, including our innovative Mobile Metal Ion (MMI™) technology, we can help you in the discovery of all categories of ore systems, including critical metals, industrial materials, base and precious metal deposits.

## Multi-Element Exploration ICP-OES and ICP-MS Packages

### Sample digestion

Sample digestion is the most important parameter to consider when choosing an analytical method. There are several types of digestion available, including:

- Aqua regia digestion
- Four acid digestion
- Sodium peroxide fusion
- Lithium metaborate fusion

Typically, reconnaissance exploration grade samples (including regional soil samples) are analyzed by aqua regia digestion followed by a multi-element scan for base metals, trace and lithological elements.

Drill-core and rock samples are generally analyzed by four acid or fusion digestion, with a multi-element finish. Where metal contents are high, samples can require further testing by other methods to ensure data is precise and accurate enough for regulatory reporting. Refer to the Ore-Grade Analysis section in this guide.

### Instrumentation

ICP-OES and ICP-MS are accepted in the mineral exploration industry as rapid and cost-effective means of analysis, because they determine many elements at low detection limits and wide ranges. Other instruments that can be used for specific elements are AAS (Atomic Absorption Spectrophotometer) and Hydride AAS.

### Aqua Regia Digestion

Aqua regia is a combination of hydrochloric and nitric acids in a nominal 3:1 ratio. This is a weak digestion for geological samples that is appropriate for initial site exploration. Aqua regia will not break down silicate and other refractory minerals, providing partial results for most elements. ICP-OES, ICP-MS or a combination of both techniques can be used to measure these digests. A minimum 0.5g sample is required.

Note: For samples containing high levels of organic materials or sulphide minerals, a modified aqua regia method (GE\_ICP22B20 and/or GE\_IMS22B20) is recommended.

#### GE\_ICP21B20 AQUA REGIA DIGESTION / ICP-OES PACKAGE

ELEMENTS AND LIMIT(S)		
Ag 2 - 100 ppm	Hg 1 - 10,000 ppm	Sb 5 - 10,000 ppm
Al 0.005 - 15%	K 0.005 - 15%	Sc 0.5 - 10,000 ppm
As 3 - 10,000 ppm	La 0.5 - 10,000 ppm	Sn 10 - 10,000 ppm
Ba 2 - 10,000 ppm	Li 1 - 10,000 ppm	Sr 0.5 - 10,000 ppm
Be 0.5 - 2,500 ppm	Mg 0.001 - 15%	Ti 0.001 - 15%
Bi 5 - 10,000 ppm	Mn 2 - 10,000 ppm	V 1 - 10,000 ppm
Ca 0.002 - 15%	Mo 1 - 10,000 ppm	W 10 - 10,000 ppm
Cd 1 - 10,000 ppm	Na 0.005 - 15%	Y 0.5 - 10,000 ppm
Co 1 - 10,000 ppm	Ni 1 - 10,000 ppm	Zn 1 - 10,000 ppm
Cr 1 - 10,000 ppm	P 0.003 - 15%	Zr 0.5 - 10,000 ppm
Cu 0.5 - 10,000 ppm	Pb 2 - 10,000 ppm	
Fe 0.01 - 15%	S 0.01 - 5%	

Note: Additional elements can be added please enquire.





GE\_IMS21B20 AQUA REGIA DIGESTION / ICP-MS PACKAGE

ELEMENTS AND LIMIT(S)

Ag 0.01 - 10 ppm	Ga 0.1 - 10,000 ppm	Sb 0.05 - 10,000 ppm
Al 0.01 - 10%	Hg 0.01 - 100 ppm	Sc 0.1 - 10,000 ppm
As 1 - 10,000 ppm	K 0.01 - 10%	Sn 0.2 - 1,000 ppm
Ba 5 - 10,000 ppm	La 0.1 - 10,000 ppm	Sr 0.5 - 10,000 ppm
Be 0.05 - 100 ppm	Mg 0.01 - 15%	Th 0.05 - 10,000 ppm
Bi 0.01 - 10,000 ppm	Mn 2 - 10,000 ppm	Ti 0.01 - 10%
Ca 0.01 - 15%	Mo 0.05 - 10,000 ppm	Tl 0.02 - 10,000 ppm
Cd 0.01 - 10,000 ppm	Na 0.01 - 10%	U 0.05 - 10,000 ppm
Ce 0.02 - 1,000 ppm	Ni 0.2 - 10,000 ppm	V 1 - 10,000 ppm
Co 0.1 - 10,000 ppm	P 0.01 - 1%	W 0.05 - 10,000 ppm
Cr 1 - 10,000 ppm	Pb 0.2 - 10,000 ppm	Y 0.05 - 10,000 ppm
Cu 0.5 - 10,000 ppm	Rb 0.05 - 10,000 ppm	Zn 1 - 10,000 ppm
Fe 0.01 - 15%		

ICP21B20 & IMS21B20 AQUA REGIA DIGESTION / COMBINED ICP-OES AND ICP-MS PACKAGE

ELEMENTS AND LIMIT(S)

Ag 0.01 - 100 ppm	Hg 0.01 - 100 ppm	Sc 0.1 - 10,000 ppm
Al 0.005 - 15%	In 0.005 - 500 ppm	Se 1 - 1,000 ppm
As 1 - 10,000 ppm	K 0.005 - 15%	Sn 0.2- 1,000 ppm
Ba 2 - 10,000 ppm	La 0.1 - 10,000 ppm	Sr 0.5 - 10,000 ppm
Be 0.05 - 100 ppm	Li 0.5 - 10,000 ppm	Ta 0.01 - 10,000 ppm
Bi 0.01 - 10,000 ppm	Lu 0.01 - 1,000 ppm	Tb 0.02 - 10,000 ppm
Ca 0.002 - 15%	Mg 0.001 - 15%	Te 0.05 - 1,000 ppm
Cd 0.01 - 10,000 ppm	Mn 2 - 10,000 ppm	Th 0.05 - 10,000 ppm
Ce 0.02 - 1,000 ppm	Mo 0.05 - 10,000 ppm	Ti 0.001 - 15%
Co 0.1 - 10,000 ppm	Na 0.005 - 15%	Tl 0.02 - 10,000 ppm
Cr 1 - 10,000 ppm	Nb 0.05 - 1,000 ppm	U 0.05 - 10,000 ppm
Cs 0.05 - 1,000 ppm	Ni 0.2 - 10,000 ppm	V 1 - 10,000 ppm
Cu 0.5 - 10,000 ppm	P 0.003 - 15%	W 0.05 - 10,000 ppm
Fe 0.01 - 15%	Pb 0.2 - 10,000 ppm	Y 0.05 - 10,000 ppm
Ga 0.1 - 10,000 ppm	Rb 0.05 - 10,000 ppm	Yb 0.1 - 100 ppm
Ge 0.1 - 10,000 ppm	S 0.01 - 5%	Zn 1 - 10,000 ppm
Hf 0.05 - 500 ppm	Sb 0.05 - 10,000 ppm	Zr 0.5 - 10,000 ppm

GO\_ICP21B100 AQUA REGIA DIGESTION FOR OVER RANGE ELEMENTS/ICP-OES

ELEMENTS AND LIMIT(S)

Ag 0.001 - 0.1%	Cu 0.01 - 30%	Ni 0.001 - 10%
As 0.01 - 10%	Fe 0.01 - 30%	Pb 0.001 - 10%
Cd 0.001 -10%	Mn 0.01 - 10%	S 0.01 - 30%
Co 0.001 - 10%	Mo 0.001 - 10%	Zn 0.01 - 10%

GE\_HAS21B20 TWO ACID / AQUA REGIA DIGESTION / HYDRIDE AAS PACKAGE

ELEMENTS AND LIMIT(S)

As 0.1 - 500 ppm	Sb 0.1 - 500 ppm	Te 0.1 - 500 ppm
Bi 0.1 - 500 ppm	Se 0.1 - 500 ppm	



MULTI-ACID DIGESTS

Multi-acid (Four acid) digestion is a very effective dissolution procedure for a large number of mineral species and is suitable for a wide range of elements. Multi-acid digestion uses a combination of HNO<sub>3</sub> (nitric acid), HF (hydrofluoric acid), HClO<sub>4</sub> (perchloric acid) and HCl (hydrochloric acid). Because hydrofluoric acid dissolves silicate minerals, these digestions are often referred to as “near-total digestions”. Requires a minimum sample weight of 0.5g. Lower and upper limit can vary slightly among SGS laboratories because some laboratories may not have access to high purity reagents and consumables. Please talk with your local laboratory manager to make sure you get the reporting limits you need.

NOTE: Refractory minerals such as oxides have limited solubility in multi-acid (Four acid) digestions. Often elements can precipitate or volatilize during digestion. These factors can compromise analytical results for Al, As, Ba, Cr, Hf, Mo, Mn, Nb, Pb, Sb, Se, Sn, Te, Th, Ti, Ta, U, W, Zr and rare earth elements in some sample types.

GE\_ICP40Q12 FOUR ACID DIGESTION / ICP-OES PACKAGE

ELEMENTS AND LIMIT(S)

Ag 2 - 100 ppm	Fe 0.01 - 15%	S 0.005 - 5%
Al 0.01 - 15%	K 0.01 - 15%	Sb 5 - 10,000 ppm
As 3 - 10,000 ppm	La 0.5 - 10,000 ppm	Sc 0.5 - 10,000 ppm
Ba 1 - 10,000 ppm	Li 1 - 10,000 ppm	Sn 10 - 10,000 ppm
Be 0.5 - 2500 ppm	Mg 0.002 - 15%	Sr 0.5 - 10,000 ppm
Bi 5 - 10,000 ppm	Mn 2 - 10,000 ppm	Ti 0.001 - 15%
Ca 0.005 - 15%	Mo 1 - 10,000 ppm	V 2 - 10,000 ppm
Cd 1 - 10,000 ppm	Na 0.005 - 15%	W 10 - 10,000 ppm
Co 1 - 10,000 ppm	Ni 1 - 10,000 ppm	Y 0.5 - 10,000 ppm
Cr 1 - 10,000 ppm	P 0.001 - 15%	Zn 1 - 10,000 ppm
Cu 0.5 - 10,000 ppm	Pb 2 - 10,000 ppm	Zr 0.5 - 10,000 ppm

Note: Additional elements can be added. Please enquire.

GE\_ICP40Q12 & GE\_IMS40Q12 FOUR ACID DIGESTION / COMBINED ICP-OES AND ICP-MS PACKAGE

ELEMENTS AND LIMIT(S)

Ag 0.02 - 100 ppm	K 0.01 - 15%	Sn 0.2 - 1,000 ppm
Al 0.01 - 15%	La 0.05 - 10,000 ppm	Sr 0.5 - 10,000 ppm
As 1 - 10,000 ppm	Li 0.2 - 10,000 ppm	Ta 0.05 - 10,000 ppm
Ba 1 - 10,000 ppm	Lu 0.01 - 1,000 ppm	Tb 0.05 - 10,000 ppm
Be 0.05 - 2,500 ppm	Mg 0.002 - 15%	Te 0.05 - 1,000 ppm
Bi 0.01 - 10,000 ppm	Mn 2 - 10,000 ppm	Th 0.01 - 10,000 ppm
Ca 0.005 - 15%	Mo 0.05 - 10,000 ppm	Ti 0.001 - 15%
Cd 0.02 - 10,000 ppm	Na 0.005 - 15%	Tl 0.02 - 10,000 ppm
Ce 0.05 - 1,000 ppm	Nb 0.1 - 1,000 ppm	U 0.05 - 10,000 ppm
Cs 0.05 - 1,000 ppm	Ni 1 - 10,000 ppm	V 2 - 10,000 ppm
Co 0.1 - 10,000 ppm	P 0.001 - 15%	W 0.1 - 10,000 ppm
Cr 1 - 10,000 ppm	Pb 0.5 - 10,000 ppm	Y 0.1 - 10,000 ppm
Cu 0.5 - 10,000 ppm	Rb 0.1 - 10,000 ppm	Yb 0.1 - 1,000 ppm
Fe 0.01 - 15%	S 0.005 - 5%	Zn 1 - 10,000 ppm
Ga 0.05 - 1000 ppm	Sb 0.05 - 10,000 ppm	Zr 0.5 - 1,000 ppm
Hf 0.02 - 500 ppm	Sc 0.1 - 10,000 ppm	
In 0.005 - 500 ppm	Se 1 - 1,000 ppm	

Note: Select packages for rare earth elements can be found on [page 46](#).





GO\_ICP42Q100 FOUR ACID DIGESTION FOR OVER RANGE ELEMENTS/ICP-OES

ELEMENTS AND LIMIT(S)

Ag 0.01 - 0.1%	Cu 0.01 - 30%	Ni 0.001 - 10%
Al 0.1 - 30%	Fe 0.1 - 30%	Pb 0.01 - 30%
As 0.01 - 10%	Li 0.01 - 10%	S 0.01 - 10%
Ca 0.1 - 30%	Mg 0.1 - 30%	Zn 0.01 - 30%
Cd 0.001 - 10%	Mn 0.001 - 10%	
Co 0.001 - 10%	Mo 0.001 - 10%	

Note: Additional elements can be added upon request.

Fusion packages

Fusion involves the complete digestion of the sample in a molten flux.

Fusions are typically more aggressive than acid digestion methods and are suitable for many refractory minerals such as chromite, ilmenite, spinel, cassiterite, lithium containing species and minerals of the tantalum-tungsten solid solution series. Fusion analyses result in complete dissolution of samples and are referred to as ‘total analyses.’

SODIUM PEROXIDE FUSION

Sodium peroxide is a strongly oxidizing basic flux that renders most refractory minerals soluble. The sample is fused in a zirconium crucible and the temperature is kept relatively low, allowing the measurement of elements that are volatilized at the higher temperatures of lithium borate fusions. Samples can be measured using ICP-OES or a combination with ICP-MS. Some laboratories offer an alternate scheme using glassy carbon crucibles (GE\_ICP91A50 and GE\_IMS91A50) to include Zr and Ag. Alternate dissolution using hydrochloric acid (GE\_ICP92A50 and GE\_IMS92A50) is also available. Please contact your local laboratory for the best approach for your samples. Requires a minimum sample weight of 0.2g.

GE\_ICP90A50 SODIUM PEROXIDE FUSION / ICP-OES PACKAGE

ELEMENTS AND LIMIT(S)

Al 0.01 - 25%	K 0.1 - 25%	Sc 5 - 50,000 ppm
As 30 - 100,000 ppm	La 10 - 50,000 ppm	Si 0.1 - 30%
Ba 10 - 50,000 ppm	Li 10 - 50,000 ppm	Sn 50 - 50,000 ppm
Be 5 - 25,000 ppm	Mg 0.01 - 25%	Sr 10 - 5,000 ppm
Ca 0.1 - 25%	Mn 10 - 100,000 ppm	Ti 0.01 - 25%
Cd 10 - 50,000 ppm	Mo 10 - 50,000 ppm	V 10 - 50,000 ppm
Co 10 - 50,000 ppm	Ni 10 - 100,000 ppm	W 50 - 40,000 ppm
Cr 20 - 50,000 ppm	P 0.01 - 25%	Y 5 - 25,000 ppm
Cu 10 - 50,000 ppm	Pb 20 - 100,000 ppm	Zn 10 - 50,000 ppm
Fe 0.01 - 25%	Sb 50 - 100,000 ppm	



GE\_ICP90A50 & GE\_IMS90A50 SODIUM PEROXIDE FUSION / COMBINED ICP-OES AND ICP-MS PACKAGE

ELEMENTS AND LIMIT(S)

Al 0.01 - 25%	Ho 0.05 - 1,000 ppm	Si 0.1 - 30%
As 3 - 10,000 ppm	In 0.2 - 1,000 ppm	Sm 0.1 - 1,000 ppm
Ba 10 - 50,000 ppm	K 0.1 - 25%	Sn 10 - 10,000 ppm
Be 5 - 25,000 ppm	La 0.1 - 10,000 ppm	Sr 10 - 5,000 ppm
Bi 0.1 - 1,000 ppm	Li 10 - 50,000 ppm	Ta 0.5 - 10,000 ppm
Ca 0.1 - 25%	Lu 0.05 - 1,000 ppm	Tb 0.05 - 1,000 ppm
Cd 0.2 - 10,000 ppm	Mg 0.01 - 25%	Th 0.1 - 1,000 ppm
Ce 0.1 - 10,000 ppm	Mn 10 - 100,000	Ti 0.01 - 25%
Co 0.5 - 10,000 ppm	Mo 2 - 10,000 ppm	Tl 0.5 - 1,000 ppm
Cr 20 - 50,000 ppm	Nb 2 - 10,000 ppm	Tm 0.05 - 1,000 ppm
Cs 0.1 - 10,000 ppm	Nd 0.1 - 10,000 ppm	U 2 - 10,000 ppm
Cu 10 - 50,000 ppm	Ni 10 - 100,000 ppm	V 10 - 50,000 ppm
Dy 0.05 - 1,000 ppm	P 0.01 - 25%	W 5 - 10,000 ppm
Er 0.05 - 1,000 ppm	Pb 2 - 10,000 ppm	Y 0.5 - 10,000 ppm
Eu 0.05 - 1,000 ppm	Pr 0.05 - 1,000 ppm	Yb 0.1 - 1,000 ppm
Fe 0.01 - 25%	Rb 2 - 10,000 ppm	Zn 10 - 50,000 ppm
Ga 1 - 1,000 ppm	Sb 1 - 10,000 ppm	
Gd 0.05 - 1,000 ppm		

Note: Ag, Hf & Zr are available under package GE\_ICM91A50, please contact our local team for details.

GO\_ICP90Q100 SODIUM PEROXIDE FUSION FOR OVER RANGE ELEMENTS/ICP-OES

ELEMENTS AND LIMIT(S)

As 0.01 – 20%	Mg 0.01 – 30%	Sb 0.01 – 20%
Bi 0.01 – 10%	Mn 0.01 – 30%	Zn 0.01 - 30%
Co 0.01 - 30%	Mo 0.01 - 30%	
Cu 0.01 - 30%	Ni 0.01 - 30%	
Fe 0.05 - 50%	Pb 0.01 - 30%	

Requires a minimum sample weight of 0.5 g. For samples containing these elements at greater than the upper limit an alternative technique will be used for full recovery.

GE\_HAS90A20

ELEMENTS AND LIMIT(S)

As 0.5 - 1,000 ppm	Bi 0.5 - 1,000 ppm	Sb 0.5 - 1,000 ppm
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LITHIUM METABORATE FUSION

Lithium metaborate fusion is a high temperature procedure that dissolves rock forming minerals, trace minerals and refractory minerals. Lithium metaborate fusion solutions can be analyzed by ICP-OES, ICP-MS or a combination of both. This technique requires a minimum sample weight of 0.2 g.

LITHIUM METABORATE FUSION / ICP-MS PACKAGE

GE\_IMS95A50

ELEMENTS AND LIMIT(S)

Ce 0.1 - 10,000 ppm	La 0.1 - 10,000 ppm	Ta 0.5 - 10,000 ppm
Co 0.5 - 10,000 ppm	Lu 0.05 - 1,000 ppm	Tb 0.05 - 1,000 ppm
Cs 0.1 - 10,000 ppm	Mo 2 - 10,000 ppm	Th 0.1 - 1,000 ppm
Cu 5 - 10,000 ppm	Nb 1 - 10,000 ppm	Tm 0.05 - 1,000 ppm
Dy 0.05 - 1,000 ppm	Nd 0.1 - 10,000 ppm	U 0.05 - 10,000 ppm
Er 0.05 - 1,000 ppm	Ni 5 - 10,000 ppm	V 5 - 10,000 ppm
Eu 0.05 - 1,000 ppm	Pr 0.05 - 1,000 ppm	W 1 - 10,000 ppm
Ga 1 - 1,000 ppm	Rb 0.2 - 10,000 ppm	Y 0.5 - 1,000 ppm
Gd 0.05 - 1,000 ppm	Sm 0.1 - 1,000 ppm	Yb 0.1 - 1,000 ppm
Hf 1 - 10,000 ppm	Sn 1 - 10,000 ppm	Zr 0.5 – 1,000 ppm
Ho 0.05 - 1,000 ppm		

Note: Lithium metaborate fusion whole rock ICP-OES package GO\_ICP95A50 can be found on [page 40](#).

Individual Methods for Exploration Grade Analysis

SULPHUR AND CARBON

CODE(S)	ELEMENT	LIMIT(S)	DESCRIPTION	MIN. SAMPLE WT.(g)
GE_CSA06V	S	0.005 - 30%	IR combustion	0.1 - 0.3
	C	0.005 - 30%		0.1 - 0.3
GE_CSA07D	SO <sub>4</sub> <sup>2-</sup>	0.01 - 30%	Leach/ICP-OES	1.0
GE_CSA08Q	S <sup>2-</sup>	≥ 0.01 %	Leach/ IR combustion	0.2
GE_CSB02V	CO <sub>2</sub> (Carbonate)	≥ 0.05%	Coulometry	0.02 - 0.1
GE_CSA03B	C (organic)	0.01 - 40%	Leach/IR combustion	0.25
	C (inorganic)	0.01 - 30%		
GE_CSB03V	C (organic)	≥ 0.05%	Coulometry	0.02 - 0.1
	C (inorganic)	≥ 0.01 %		
GE_CSA05V	C (graphitic)	0.05 - 50%	Leach/IR combustion	0.05
GE_CSB05V	C (graphitic)	≥ 0.05%	Coulometry	0.1

ADDITIONAL SINGLE ELEMENTS

CODE(S)	ELEMENT	LIMIT(S)	DESCRIPTION	MIN. SAMPLE WT.(g)
GE_CVA37A25	Hg	0.005 - 100 ppm	Cold vapour AAS	0.15
GE_ISE20V	F	25 - 100,000 ppm	Ion selective electrode	0.1
GE_ISE30V	Cl	50 - 5,000 ppm	Ion selective electrode	0.2
GO_CLA30V	Cl	25 - 20,000 ppm	Titration	10

SGS offers a wide variety of specific element analyzes. Please contact your local site.



Mobile Metal ION – MMI™ Soil Geochemistry

SGS is the owner and sole provider of MMI™ Technology. We have over 20 years of experience with this technology, and we are the market leaders in providing a weak extraction of the mobile form of the ions residing in near surface soils. MMI™ is a world-renowned exploration tool repeatedly proven to find buried mineral deposits.

MMI™ Technology is an innovative analytical process that uses a unique analysis of metals in soils and weathered materials. Target elements are extracted using weak solutions of organic and inorganic compounds rather than conventional aggressive acid-based digests. MMI™ solutions contain strong ligands, which detach and hold the metal ions that were loosely bound to soil particles by weak atomic forces. The extraction does not dissolve the bound forms of metal ions. Thus, metal ions in MMI solutions are the chemically active or ‘mobile’ component of the sample. Because these mobile, loosely bound complexes are in very low concentrations, elemental determinations are made by conventional or cell-based ICP-MS.

There are many benefits to using MMI™ Technology for soil geochemistry, including:

- Few false anomalies
- Focused anomalies
- Minimal nugget effects

Sample Collection

Sample collection is the most critical part of a soil geochemistry program. The MMI™ Technology has specific sampling protocols based on years of experience and research. In the absence of an orientation survey, samples must be taken at a constant depth (10-25 cm) below the organic-inorganic soil interface. There is no sample preparation or drying. The analysis is done on a 50g sample and the extracted solution is analyzed via ICP-MS, providing determinations in the part per billion range. For detailed instructions of the MMI™ sampling protocols and orientation surveys, please visit [sgs.com/geochemistry](https://www.sgs.com/geochemistry) or contact us at [naturalresources@sgs.com](mailto:naturalresources@sgs.com).

Additional MMI Analyses

The application of ICP-MS cell technology to the analysis of MMI samples results in lower detection limits due to the removal of interferences. This means better definition of anomalous targets, for example, in the exploration of nickel deposits, kimberlites and layered intrusions. Here, chromium, an important geological trace element, can be measured down to 1ppb.

Similarly, for uranium exploration, low level vanadium (1ppb) is also important. These can be measured using an enhanced package, scheme code GE\_MMIME. Additional elements such as S, B, Br, I, and Pb isotopes can also be measured as required.





GE\_MMIM MOBILE METAL ION STANDARD PACKAGE / ICP-MS

ELEMENTS AND LIMIT(S)

Ag ≥ 0.5 ppb	Er ≥ 0.2 ppb	Nd ≥ 1 ppb	Tb ≥ 0.1 ppb
Al ≥ 1 ppm	Eu ≥ 0.2 ppb	Ni ≥ 5 ppb	Te ≥ 10 ppb
As ≥ 10 ppb	Fe ≥ 1 ppm	P ≥ 0.1 ppm	Th ≥ 0.5 ppb
Au ≥ 0.1 ppb	Ga ≥ 0.5 ppb	Pb ≥ 5 ppb	Ti ≥ 10 ppb
Ba ≥ 10 ppb	Gd ≥ 0.5 ppb	Pd ≥ 1 ppb	Tl ≥ 0.1 ppb
Bi ≥ 0.5 ppb	Hg ≥ 1 ppb	Pr ≥ 0.5 ppb	U ≥ 0.5 ppb
Ca ≥ 2 ppm	In ≥ 0.1 ppb	Pt ≥ 0.1 ppb	W ≥ 0.5 ppb
Cd ≥ 1 ppb	K ≥ 0.5 ppm	Rb ≥ 1 ppb	Y ≥ 1 ppb
Ce ≥ 2 ppb	La ≥ 1 ppb	Sb ≥ 0.5 ppb	Yb ≥ 0.2 ppb
Co ≥ 1 ppb	Li ≥ 1 ppb	Sc ≥ 5 ppb	Zn ≥ 10 ppb
Cr ≥ 100 ppb	Mg ≥ 0.5 ppm	Sm ≥ 1 ppb	Zr ≥ 2 ppb
Cs ≥ 0.2 ppb	Mn ≥ 100 ppb	Sn ≥ 1 ppb	
Cu ≥ 10 ppb	Mo ≥ 2 ppb	Sr ≥ 10 ppb	
Dy ≥ 0.5 ppb	Nb ≥ 0.5 ppb	Ta ≥ 1 ppb	

GE\_MMIMP

ELEMENTS AND LIMIT(S)

Ag ≥ 0.1ppb	Au ≥ 0.05ppb	Pd ≥ 0.2ppb	Pt ≥ 0.02ppb
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Biogeochemistry

SGS has considerable experience in the preparation and analysis of a wide range of vegetation samples. Such samples may be dried and macerated or ashed prior to acid digestion and analysis by ICP-OES (GE\_ICP23D50) and ICP-MS (GE\_IMS23D50).

GE\_ICP23D50

ELEMENTS AND LIMITS

Al 12 - 150,000 ppm	K 7 - 250,000ppm	S 42 - 410,000 ppm
B 10 - 10,000 ppm	Li 0.2 - 50,000 ppm	Sr 0.5 - 10,000 ppm
Ba 1 - 10,000 ppm	Mg 9 - 150,000 ppm	Ti 1 - 150,000 ppm
Ca 30 - 150,000 ppm	Mn 2 - 10,000 ppm	V 20 - 10,000 ppm
Cr 10 - 10,000 ppm	Na 12 - 150,000 ppm	Zn 1 - 10,000 ppm
Cu 0.5 - 10,000 ppm	Ni 1 - 10,000 ppm	Zr 0.05 - 10,000 ppm
Fe 7 - 150,000 ppm	P 18 - 250,000 ppm	

Note: Vegetation sample preparation: Dry and macerate sample (G\_DRY\_KG, VEG10\_WT)) or ash at 475°C (G\_PRP, PRP\_ASH).

GE\_IMS23D50

ELEMENTS AND LIMITS

Ag 0.01 - 10 ppm	Ga 1 - 10,000 ppm	Pb 0.5 - 10,000 ppm	Ta 0.2 - 10,000 ppm
As 10 - 10,000 ppm	Gd 0.01 - 1,000 ppm	Pd 0.01 - 500 ppm	Tb 0.002 - 10,000 ppm
Au 0.005 - 5 ppm	Hf 0.5 - 500 ppm	Pr 0.005 - 1,000 ppm	Te 0.1 - 1,000 ppm
Bi 0.005 - 10,000 ppm	Hg 0.02 - 10,000 ppm	Pt 0.005 - 350 ppm	Th 0.002 - 10,000 ppm
Cd 0.03 - 10,000 ppm	Ho 0.002 - 500 ppm	Rb 0.2 - 10,000 ppm	Tl 0.002 - 1,000 ppm
Ce 0.01 - 1,000 ppm	In 0.005 - 500 ppm	Rh 0.001 - 500 ppm	Tm 0.002 - 1,000 ppm
Co 0.01 - 10,000 ppm	Ir 0.002 - 500 ppm	Sb 0.04 - 10,000 ppm	U 0.001 - 10,000 ppm
Cs 0.005 - 1,000 ppm	La 0.01 - 10,000 ppm	Sc 0.3 - 10,000 ppm	W 0.01 - 10,000 ppm
Dy 0.005 - 1,000 ppm	Lu 0.002 - 10,000 ppm	Se 5 - 1,000 ppm	Y 0.01 - 10,000 ppm
Er 0.005 - 1,000 ppm	Mo 0.05 - 10,000 ppm	Sm 0.005 - 1,000 ppm	Yb 0.002 - 100 ppm
Eu 0.002 - 1,000 ppm	Nd 0.02 - 10,000 ppm	Sn 0.4 - 1,000 ppm	

Note: Vegetation sample preparation: Dry and macerate sample (G\_DRY\_KG, VEG10\_WT)) or ash at 475°C (G\_PRP, PRP\_ASH).



Hydrogeochemistry

The analyzes offered in this section are suitable for groundwater samples used in mineral exploration, but NOT for salt water, brines, effluent solutions and metal-carrying solutions generated in processing circuits or environmental applications. Requests for environmental services will be forwarded to an SGS Environmental Services Laboratory.

GE\_ICP80T GROUND WATER ANALYSIS / ICP-OES PACKAGE

ELEMENTS AND LIMIT(S)

Ag ≥ 0.001 ppm	Co ≥ 0.01 ppm	Mn ≥ 0.005 ppm	Sn ≥ 0.05 ppm
Al ≥ 0.05 ppm	Cr ≥ 0.01 ppm	Mo ≥ 0.01 ppm	Sr ≥ 0.001 ppm
As ≥ 0.03 ppm	Cu ≥ 0.005 ppm	Na ≥ 0.05 ppm	Ti ≥ 0.01 ppm
Ba ≥ 0.01 ppm	Fe ≥ 0.05 ppm	Ni ≥ 0.01 ppm	V ≥ 0.01 ppm
Be ≥ 0.005 ppm	K ≥ 0.1 ppm	P ≥ 0.05 ppm	W ≥ 0.05 ppm
Bi ≥ 0.05 ppm	La ≥ 0.01 ppm	Pb ≥ 0.03 ppm	Y ≥ 0.005 ppm
Ca ≥ 0.05 ppm	Li ≥ 0.01 ppm	Sb ≥ 0.05 ppm	Zn ≥ 0.005 ppm
Cd ≥ 0.01 ppm	Mg ≥ 0.05 ppm	Sc ≥ 0.001 ppm	Zr ≥ 0.01 ppm

Note: B, S and Si can be added upon request.

GE\_IMS80T GROUND WATER ANALYSIS / ICP-MS PACKAGE

ELEMENTS AND LIMIT(S)

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

Note: Au, Pt, Pd, Rh, Ru and Ir can be added upon request.

ADDITIONAL GROUND WATER ANALYSIS

CODE(S)	ELEMENT	DESCRIPTION
G_PHY14V	Total dissolved solids (TDS)	Gravimetric
GC_ISE10T	pH	Ion selective electrode (ISE)
GE_ISE21T	Fluoride F <sup>-</sup>	Ion selective electrode (ISE)
GE_ISE30T	Chloride Cl <sup>-</sup>	Ion selective electrode (ISE)





Lithogeochemistry

Lithogeochemical analysis is used for basic rock characterisation based on major, minor and trace element chemistry. It requires whole rock analytical methods to ensure that refractory minerals such as zircon and chromite are fully dissolved.

Lithogeochemical analysis may be used in exploration programs for identification of different rock types that might occur in drill core or at outcrop, particularly when primary lithologies are obscured by subsequent alteration or metamorphic events.

Lithogeochemical analysis is also used by geological surveys undertaking geological mapping projects, by researchers studying geological, geochemical and petrological processes and by oil companies requiring complete rock characterization for calibrating core responses to borehole sensors.

GO\_ICP95A50 LITHIUM METABORATE FUSION / ICP-OES (LITHOLOGIC) PACKAGE

ELEMENTS AND LIMIT(S)			
Al <sub>2</sub> O <sub>3</sub> 0.01 - 75%	MnO 0.01 - 10%	*LOI -10 - 100%	
CaO 0.01 - 60%	Na <sub>2</sub> O 0.01 - 30%		
Cr <sub>2</sub> O <sub>3</sub> 0.01 - 10%	P <sub>2</sub> O <sub>5</sub> 0.01 - 25%		
Fe <sub>2</sub> O <sub>3</sub> 0.01 - 75%	SiO <sub>2</sub> 0.01 - 90%		
K <sub>2</sub> O 0.01 - 25%	TiO <sub>2</sub> 0.01 - 25%		
MgO 0.01 - 30%	V <sub>2</sub> O <sub>5</sub> 0.01 - 10%		

Note: This is the recommend package for whole rock analysis of sulphide rich, mineralized samples. Requires a minimum sample weight of 0.1g. Note: Ba, Nb, Sc, Sr, Y, Zn and Zr can be added upon request. \*G\_PHY01V or G\_PHY02V

SULPHUR AND CARBON

CODE	ELEMENT	LIMIT(S)	DESCRIPTION
GO_CSA06V	S	0.01 - 75%	IR combustion
	C	0.01 - 75%	

Note: Requires a minimum sample weight of 0.2 g. Carbon and sulphur can be speciated using a variety of methods. Please enquire.

GO\_XRF72 BORATE FUSION / WD XRF WHOLE ROCK PACKAGE

Analyte	Reported as	Package Majors	Package-P	Package Maj/Min	Range
Al	Al <sub>2</sub> O <sub>3</sub>	X	X	X	0.01 - 100%
As	As <sub>2</sub> O <sub>3</sub>		X	Extension/Optional Oxide	0.01 - 5%
Ba	BaO	X	X	X	0.01 - 70%
Bi	Bi <sub>2</sub> O <sub>3</sub>			Extension/Optional Oxide	0.01 - 5%
Ca	CaO	X	X	X	0.01 - 60%
Cl	Cl		X	X	0.01 - 30%
Co	Co <sub>3</sub> O <sub>4</sub>		X	X	0.01 - 5%
Cr	Cr <sub>2</sub> O <sub>3</sub>		X	X	0.01 - 5%
Cu	CuO		X	X	0.01 - 5%
F	F			Extension/Optional element	0.5 - 50%
Fe	Fe <sub>2</sub> O <sub>3</sub>	X	X	X	0.01 - 100%
Hf	HfO <sub>2</sub>			Extension/Optional Oxide	0.01 - 5%
K	K <sub>2</sub> O	X	X	X	0.01 - 70%
Mg	MgO	X	X	X	0.01 - 100%
Mn	Mn <sub>3</sub> O <sub>4</sub>	X	X	X	0.01 - 100%
Mo	MoO <sub>3</sub>			Extension/Optional Oxide	0.01 - 5%
Na	Na <sub>2</sub> O	X	X	X	0.01 - 60%
Ni	NiO		X	X	0.01 - 5%
P	P <sub>2</sub> O <sub>5</sub>	X	X	X	0.01 - 55%
Pb	PbO		X	Extension/Optional Oxide	0.01 - 5%
Rb	Rb <sub>2</sub> O			Extension/Optional Oxide	0.01 - 5%
Sb	Sb <sub>2</sub> O <sub>3</sub>			Extension/Optional Oxide	0.01 - 5%
Si	SiO <sub>2</sub>	X	X	X	0.01 - 100%
Sn	SnO <sub>2</sub>		X	Extension/Optional Oxide	0.01 - 5%
S	SO <sub>3</sub>	X	X	X	0.01 - 10%
Sr	SrO		X	X	0.01 - 5%
Ta	Ta <sub>2</sub> O <sub>5</sub>			Extension/Optional Oxide	0.01 - 5%
Th	ThO <sub>2</sub>			Extension/Optional Oxide	0.01 - 1%
Ti	TiO <sub>2</sub>	X	X	X	0.01 - 100%
U	U <sub>3</sub> O <sub>8</sub>			Extension/Optional Oxide	0.01 - 5%
V	V <sub>2</sub> O <sub>5</sub>	X	X	X	0.01 - 10%
W	WO <sub>3</sub>			Extension/Optional Oxide	0.01 - 5%
Zn	ZnO		X	X	0.01 - 5%
Zr	ZrO <sub>2</sub>		X	X	0.01 - 5%
LOI (1000°C)*		X	X	X	-10 - 100%
Moisture (as received)		Optional	Optional	Optional	≥ 0.01%

\*G\_PHY01V or G\_PHY02V

Unmineralized whole rock analysis; for commodities and specific matrices refer to commodity section. Specialized whole rock XRF packages are available for mineral sands exploration programs

For Ferrous iron (FeO) see [page 57](#).





# Commodities Specific Methods

## Industrial Commodities

SGS offers a wide variety of select methods to analyze specific elements, species and/or groups of elements. These methods address specific circumstances that arise due to mineralogy, chemistry or commercial requirements. A selection of commonly requested methods are listed below and others are available. Please enquire.

### Battery Metals / Critical Metals

Copper	➔
Manganese Ore	➔
Nickel	➔
Nickel Laterite	➔
Lithium	➔
Rare Earth Element Analysis	➔

### Industrial Metals

Bauxite	➔
Chromite Ore	➔
Fluorspar	➔
Generic / Multi-element Ores	➔
Graphitic Carbon	➔
Iron Ore	➔
Limestone / Lime / Industrial Minerals / Cement / Clinker / Dolomite	➔
Resistive Minerals / Tungsten Tin Ores / Concentrates	➔
Uranium	➔

## Battery metals/Critical metals

### Copper

Copper can occur as oxide, sulphide and metallic forms in mineral deposits and metallurgical products so there are a variety of different analytical techniques available.

#### EXPLORATION GRADE COPPER METHODS

CODE(S)	LIMIT(S)	DESCRIPTION
GE_ICP21B20	0.5 ppm - 1 %	Aqua regia – ICP-OES
GE_IMS21B20	0.5 ppm - 1 %	Aqua regia – ICP-MS
GE_ICP40Q12	0.5 ppm - 1 %	4-Acid digest – ICP-OES
GE_ICP90A50	10 ppm - 5 %	Fusion – ICP-OES

#### ORE-GRADE COPPER METHODS

CODE(S)	LIMIT(S)	DESCRIPTION
GO_ICP21B100	0.01 - 30 %	Aqua regia digest – ICP-OES
GO_ICP42Q100	0.01 - 30 %	4-Acid digest – ICP-OES
GO_ICP90Q100	0.01 - 30 %	Fusion – ICP-OES

#### CONCENTRATE-GRADE COPPER METHODS

CODE(S)	LIMIT(S)	DESCRIPTION
GC_CON13V	15 - 60 %	Short iodide titration
GC_CON03V*	5 - 95 %	Electrogravimetry

\* These methods can be done at party or umpire quality.

#### MINERAL SELECTIVE COPPER METHODS

CODE(S)	LIMIT(S)	DESCRIPTION
GC_AAS70D200	≥ 0.002 %	Cu oxide method, citric acid leach, AAS
GC_AAS71C50	≥ 0.001 %	Cu H <sub>2</sub> SO <sub>4</sub> soluble, AAS
GC_AAS74C50	≥ 0.001 %	Cu acetic acid soluble, AAS
GC_AAS75D100	≥ 0.001 %	CN soluble Cu, AAS
GC_AAS01D250	≥ 0.001 %	Metallic Cu, AgNO <sub>3</sub> digest, AAS
GC_ASQ01D50	≥ 0.001 %	Sequential Cu leach (H <sub>2</sub> SO <sub>4</sub> soluble Cu, Cyanide soluble Cu, residual Cu), AAS
GC_ASQ02D100		
GC_ASQ03D50		

### Manganese Ore

Industry standard XRF borate fusion method with (76) and without (72) oxidation. LOI (G\_PHY01V or G\_PHY02V) required. Oxidation method (76) recommended for ores with variable oxidation states as well as Ferro Manganese and Manganese Nodules.

#### GO\_XRF72MN /GO\_XRF76MN

ANALYTE	REPORTING AS	RANGE
Al	Al <sub>2</sub> O <sub>3</sub>	0.01 - 100 %
Ba	BaO	0.01 - 5 %
Ca	CaO	0.01 - 40 %
Cr	Cr <sub>2</sub> O <sub>3</sub>	0.01 - 10 %
Fe	Fe <sub>2</sub> O <sub>3</sub>	0.01 - 100 %
K	K <sub>2</sub> O	0.01 - 10 %
Mg	MgO	0.01 - 100 %
Mn	Mn <sub>3</sub> O <sub>4</sub>	0.01 - 100 %
Na	Na <sub>2</sub> O (only on 72)	0.01 - 10 %
P	P <sub>2</sub> O <sub>5</sub>	0.01 - 10 %
Si	SiO <sub>2</sub>	0.05 - 100 %
S	SO <sub>3</sub>	0.01 - 2 %
Ti	TiO <sub>2</sub>	0.01 - 50 %
V	V <sub>2</sub> O <sub>5</sub>	0.01 - 5 %
Zr	ZrO <sub>2</sub>	0.01 - 1 %
LOI (1000°C)*	LOI	-10 - 100 %

Dried only; Optional Elements available upon request. \*G\_PHY01V or G\_PHY02V





Nickel

Nickel is used in stainless steels, metal alloys, plating, electric batteries and chemicals. It is found in either sulphide or laterite type ores so analytical methods are needed to ensure complete digestion.

Note: Refer to the Exploration Grade Analysis section in this guide for descriptions of the GE\_ICP21B20, GE\_ICP40Q12, GE\_ICP90A50 digestion techniques. For description of the GO\_ICP21B100, GO\_ICP42Q100 and GO\_ICP90Q100 techniques, please see the Ore-Grade Analysis section.

EXPLORATION GRADE NICKEL METHODS

CODE(S)	LIMIT(S)	DESCRIPTION
GC_ICP21B20	1 ppm - 1%	Aqua regia – ICP-OES
GE_IMS21B20	0.2 ppm - 1%	Aqua regia – ICP-MS
GE_ICP40Q12	1 ppm - 1%	4-Acid digest – ICP-OES
GE_ICP90A50	10 ppm - 10%	Fusion – ICP-OES
GE_IMS90A50	10 ppm - 1%	Fusion – ICP-MS

ORE-GRADE NICKEL METHODS

CODE(S)	LIMIT(S)	DESCRIPTION
GO_ICP21B100	0.001 - 10%	Aqua regia digest – ICP-OES
GO_ICP42Q100	0.001 - 10%	4-Acid digest – ICP-OES
GO_ICP90Q100	0.01 - 30%	Fusion – ICP-OES

CONCENTRATE-GRADE NICKEL METHODS

CODE(S)	LIMIT(S)	DESCRIPTION
GC_CON07V*	5 - 100%	DMG separation / electroplating

\* This method can be done at party or umpire quality (GT).

MINERAL SELECTIVE NICKEL METHODS

CODE(S)	LIMIT(S)	DESCRIPTION
GC_AAS03D250	≥0.002%	Metallic & sulphide nickel by bromine-methanol leach, AAS finish

Note: Additional selective methods for nickel may be available. Please enquire.

Nickel Laterite

Industry standard XRF multielement method based on dried sample due to hygroscopic nature of the ore. LOI (G\_PHY01 or G\_PHY02V) required.

GO\_XRF72NL

ANALYTE	REPORTED AS	RANGE
Al	Al <sub>2</sub> O <sub>3</sub>	0.01 - 100%
As	As optional	0.01 - 1%
Ba	BaO	0.01 - 1%
Ca	CaO	0.01 - 40%
Co	Co	0.001 - 5%
Cr	Cr <sub>2</sub> O <sub>3</sub>	0.005 - 10%
Cu	Cu	0.01 - 1%
Fe	Fe <sub>2</sub> O <sub>3</sub>	0.01 - 100%
K	K <sub>2</sub> O	0.01 - 10%
Mg	MgO	0.01 - 50%
Mn	MnO	0.01 - 40%
Na	Na <sub>2</sub> O	0.01 - 5%
Ni	Ni	0.005 - 8%
P	P <sub>2</sub> O <sub>5</sub>	0.01 - 5%
Pb	Pb	0.005 - 1%
S	SO <sub>3</sub>	0.01 - 1%
Sc	Sc <sub>2</sub> O <sub>3</sub> Optional	0.01 - 1%
Si	SiO <sub>2</sub>	0.05 - 100%
Ti	TiO <sub>2</sub>	0.01 - 1%
Zn	Zn	0.001 - 2%
LOI (1000°C) *	LOI	-10 - 100%

Dried sample only. \*G\_PHY01V or G\_PHY02V





Lithium

SGS has the methodology to support exploration and production analysis of lithium. Multi-element packages are listed in the Exploration Grade Analysis section of this guide for low grade lithium samples.

LITHIUM PACKAGES FOR LOW GRADE MINERALIZATION		
CODE(S)	ELEMENTS/ LIMIT(S)	DESCRIPTION
GE_IMS21B20	0.5 - 10,000 ppm	Aqua regia digest / ICP-OES
GE_ICP40Q12	1 - 10,000 ppm	4-Acid digest / ICP-OES
GE_ICP92A50	10 - 50,000 ppm	Sodium peroxide fusion / ICP-OES
GE_IMS90A50	5 - 10,000 ppm	Sodium peroxide fusion / ICP-MS

LITHIUM PACKAGES FOR HIGHER GRADE MINERALIZATION		
CODE(S)	ELEMENTS/ LIMIT(S)	DESCRIPTION
GC_ICP92A50	≥10ppm	Sodium peroxide fusion / ICP-OES

Rare Earth Element Analysis

Rare earth element (REE) samples can be analyzed using a variety of techniques depending on the concentration levels. The following packages are available for trace to percent level concentrations. Please enquire to ensure we meet your requirements. The following exploration packages contain REEs or can have additional REEs requested.

RARE EARTH ELEMENT ADD ON TRACE PACKAGES		
CODE(S)	ADDITIONAL ELEMENTS*	DESCRIPTION
GE_ IMS40Q12	Pr, Nd, Sm, Eu, Gd, Dy, Ho, Er, Tm	4-Acid digest / ICP-MS

\* REE elements that can be added to existing package

RARE EARTH ELEMENT INCLUSIVE TRACE PACKAGES		
CODE(S)	ELEMENTS	DESCRIPTION
GE_ICP90A50 & GE_IMS90A50	Refer to pg 35	Sodium peroxide fusion / ICP-OES / ICP-MS
GE_IMS95A50	Refer to pg 36	Lithium metaborate fusion / ICP-MS

GO_IMS91Q100 SODIUM PEROXIDE FUSION / ICP-MS REE ORE GRADE PACKAGE			
ELEMENTS AND LIMIT(S)			
Ce 50 - 150,000 ppm	Ho 0.1 - 200 ppm	Sm 10 - 20,000 ppm	Y 5 -10,000 ppm
Dy 1 - 5,000 ppm	La 50 - 50,000 ppm	Tb 1 - 500 ppm	Yb 1 - 200 ppm
Er 0.5 - 200 ppm	Lu 0.2 - 200 ppm	Th 5 - 50,000 ppm	
Eu 1 - 5,000 ppm	Nd 50 - 50,000 ppm	Tm 0.1 - 200 ppm	
Gd 5 - 5,000 ppm	Pr 10 - 20,000 ppm	U 1 - 200 ppm	

Note: This technique requires a minimum sample weight of 0.5 g.



Industrial metals

Bauxite

XRF is the industry standard for bauxite analysis.

GO/GT_XRF72BX		
ANALYTE	REPORTED AS	RANGE
Al	Al <sub>2</sub> O <sub>3</sub>	0.01 - 100%
Ba	BaO	0.01 - 5%
Ca	CaO	0.01 - 5%
Cr	Cr <sub>2</sub> O <sub>3</sub>	0.01 - 1%
Fe	Fe <sub>2</sub> O <sub>3</sub>	0.01 - 50%
Ga	Ga <sub>2</sub> O <sub>3</sub> optional	0.01 - 1%
K	K <sub>2</sub> O	0.001 - 5%
Mg	MgO	0.01 - 10%
Mn	Mn <sub>3</sub> O <sub>4</sub>	0.01 - 10%
Na	Na <sub>2</sub> O	0.01 - 10%
P	P <sub>2</sub> O <sub>5</sub>	0.01 - 10%
Si	SiO <sub>2</sub>	0.05 - 100%
S	SO <sub>3</sub>	0.01 - 1%
Ti	TiO <sub>2</sub>	0.01 - 5%
V	V <sub>2</sub> O <sub>5</sub>	0.01 - 1%
Zr	ZrO <sub>2</sub>	0.01 - 1%
LOI (1000°C)*	LOI	-10 - 100%

\*G\_PHY01V or G\_PHY02V

Dried sample only.

Additional characterizations available include:

Reactive Silica and Available Alumina using standard bomb digest followed by ICP-OES analysis (GO\_ICP10V500).

Total Organic Carbon (non Carbonate) TOC and Total Carbon using IR combustion refer to [p36](#).

FTIR based characterization GE\_FTIR73BX (below) which includes the typical Bauxite minerals as well as phases correlated to chemistry.

GE_FTIR73BX	
Total Alumina 40.0 - 55.0%	Total Titanium Oxides 1.0 - 3.5%
Available Alumina 5.0 - 60.0%	Quartz 1.0 - 100.0%
Total Silica 1.0 - 60.0%	Goethite 1.0 - 20.0%
Reactive Silica 1.0 - 29.0%	Kaolinite 1.0 - 100.0%
Total Iron Oxides 1.0 - 29.0%	

Obtain quantitative infra-red spectral data using an ATR based system including total oxide weight % calibrated against borate fusion XRF and reactive silica and aluminium calibrated against classical bomb digest. Additional compounds available upon request at extra cost.





Chromite Ore

XRF method for analysis of chromite ores in a high dilution borate fusion setup.

GO_XRF72CR		
Minimum sample 1g.		
ANALYTE	REPORTED AS	RANGE
Al	Al <sub>2</sub> O <sub>3</sub>	0.02 - 100%
As	As <sub>2</sub> O <sub>3</sub> optional	0.02 - 1%
Ba	BaO	0.02 - 20%
Ca	CaO	0.02 - 40%
Co	Co <sub>3</sub> O <sub>4</sub> optional	0.02 - 5%
Cr	Cr <sub>2</sub> O <sub>3</sub>	0.02 - 60%
Cu	CuO optional	0.02 - 5%
Fe	Fe <sub>2</sub> O <sub>3</sub>	0.02 - 100%
K	K <sub>2</sub> O	0.02 - 10%
Mg	MgO	0.02 - 50%
Mn	MnO	0.02 - 50%
Na	Na <sub>2</sub> O	0.05 - 10%
Ni	NiO optional	0.02 - 10%
P	P <sub>2</sub> O <sub>5</sub>	0.02 - 10%
Pb	PbO optional	0.02 - 5%
Si	SiO <sub>2</sub>	0.05 - 100%
S	SO <sub>3</sub>	0.02 - 1%
Ti	TiO <sub>2</sub>	0.02 - 50%
V	V <sub>2</sub> O <sub>5</sub>	0.02 - 1.8%
Zn	ZnO optional	0.02 - 5%
LOI (1000°C)*	LOI	-10 - 100%
Dried only		
*G_PHY01V or G_PHY02V		
Note: Additional grinding might be needed		

Fluorspar

SGS has the methodology to support testing of fluorspar material. Due to the nature of the test this scheme is only applicable to acid grade or other soluble fluorspar products.

SOLUBLE FLUORSPAR PACKAGE		
CODE(S)	ELEMENTS/ LIMIT(S)	DESCRIPTION
GC_CLA27V	CaCO <sub>3</sub> (≥ 0.1%)	EDTA Titration
	CaF <sub>2</sub> (≥ 10%)	Calculation

Generic / Multi-element Ores

Generic ore, concentrate and metallurgical materials compatible analytical methods with a wide dynamic range using XRF.

GO_XRF70V PYROSULPHATE FUSION / XRF BASE METAL PACKAGE (10 ELEMENTS)			
ELEMENTS AND LIMITS			
Co 0.01 - 100%	Fe 0.02 - 100%	Ni 0.01 - 100%	Zn 0.01 - 100%
Cr 0.01 - 100%	Mn 0.01 - 100%	Pb 0.01 - 100%	
Cu 0.01 - 100%	Mo 0.005- 100%	W 0.02 - 100%	



The oxidizing borate fusion method (XRF76) is suitable for mineralized samples with sulphides, metal concentrates, metallurgical samples as well as ferro alloys, with the exception of FeSi. The default oxidizer is NaNO3, some sites offer LiNO3 to enable Na2O reporting. Please enquire on availability.

GO_XRF76					
Analyte	Reported as	Standard	Extension	Extension with REE	Range
Al	Al <sub>2</sub> O <sub>3</sub>	X	X	X	0.01 - 100%
As	As <sub>2</sub> O <sub>3</sub>	Optional	Optional	Optional	0.01 - 10%
Ba	BaO	X	X	X	0.01 - 40%
Bi	Bi <sub>2</sub> O <sub>3</sub>		X		0.01 - 20%
Ca	CaO	X	X	X	0.01 - 80%
Ce	Ce <sub>2</sub> O			X	0.02 - 50%
Co	Co <sub>3</sub> O <sub>4</sub>	Optional	X	X	0.01 - 100%
Cr	Cr <sub>2</sub> O <sub>3</sub>	X	X	X	0.01 - 75%
Cu	CuO	X	X	X	0.01 - 75%
Cs	Cs <sub>2</sub> O		Optional	Optional	0.01 - 25%
Dy	Dy <sub>2</sub> O <sub>3</sub>			X	0.02 - 10%
Eu	Eu <sub>2</sub> O <sub>3</sub>			X	0.02 - 10%
F	F	Optional	Optional	Optional	0.5 - 50%
Fe	Fe <sub>2</sub> O <sub>3</sub>	X	X	X	0.01 - 100%
Gd	Gd <sub>2</sub> O <sub>3</sub>			X	0.02 - 10%
Hf	HfO <sub>2</sub>	Optional	Optional	Optional	0.01 - 10%
K	K <sub>2</sub> O	X	X	X	0.01 - 40%
La	La <sub>2</sub> O <sub>3</sub>			X	0.02 - 50%
Mg	MgO	X	X	X	0.1 - 80%
Mn	Mn <sub>3</sub> O <sub>4</sub>	X	X	X	0.01 - 100%
Mo	MoO <sub>3</sub>		X		0.01 - 50%
Na	Na <sub>2</sub> O	Per Oxidizer	Per Oxidizer	Per Oxidizer	0.1 - 58%
Nb	Nb <sub>2</sub> O <sub>3</sub>		X		0.01 - 50%
Nd	Nd <sub>2</sub> O <sub>3</sub>			X	0.02 - 50%
Ni	NiO	X	X	X	0.01 - 100%
P	P <sub>2</sub> O <sub>5</sub>	X	X	X	0.01 - 40%
Pb	PbO	X	X	X	0.01 - 100%
Pr	Pr <sub>6</sub> O <sub>11</sub>			X	0.02 - 50%
Rb	Rb O		X	X	0:02 - 35%
Sb	Sb <sub>2</sub> O <sub>3</sub>		X		0.01 - 25%
Si	SiO <sub>2</sub>	X	X	X	0.1 - 100%
Sm	Sm <sub>2</sub> O <sub>3</sub>			X	0.02 - 10%
Sn	SnO <sub>2</sub>		X		0.01 - 100%
S	SO <sub>3</sub>	X	X	X	0.2 - 90%
Sr	SrO	Optional	X	X	0.01 - 20%
Ta	Ta <sub>2</sub> O <sub>5</sub>		X		0.01 - 50%
Th	ThO <sub>2</sub>		X		0.01 - 3%
Ti	TiO <sub>2</sub>	X	X	X	0.01 - 80%
U	U <sub>3</sub> O <sub>8</sub>		X		0.01 - 1%
V	V <sub>2</sub> O <sub>5</sub>	X	X	X	0.01 - 10%
W	WO <sub>3</sub>		X		0.01 - 70%
Y	Y2O3			X	0:02 - 10%
Zn	ZnO	X	X	X	0.01 - 70%
Zr	ZrO <sub>2</sub>	Optional	X		0.02 - 40%
LOI (1000°C)*		Optional	Optional	Optional	-10 - 100%
Moisture (as received)		Optional	Optional	Optional	≥ 0.01%
*G_PHY01V or G_PHY02V					





Graphitic Carbon

SGS has the methodology to support testing of graphitic carbon.

GRAPHITIC CARBON PACKAGES

CODE(S)	ELEMENTS/ LIMIT(S)	DESCRIPTION	MIN. SAMPLE WT. (g)
GE_CSB05V	C graphitic (0.05%)	Coulometry	0.1
GC_CSA05V	C graphitic (0.05%)	Leach; IR Combustion	0.2
GC_CSA06V	Total Carbon (0.01 %)	IR Combustion	0.1 - 0.3
TM_AMC561_M	*Ash content (0.01-10%)	Gravimetric	20

Note: High temperature carbon analyzer available at some sites for carbon concentrates requiring greater precision. Contact your local representative.

\*Ash content is not a suitable measurement of graphite purity for samples containing carbonates or other non-graphitic carbon species and is only recommended for samples >90% graphite.

GC\_ICP95V100 IMPURITIES FOR GRAPHITIC CARBON

ELEMENTS AND LIMIT(S)		
Al ≥ 10 ppm	K ≥ 8 ppm	P ≥ 20 ppm
Ba ≥ 0.3 ppm	Mg ≥ 3 ppm	Si ≥ 30 ppm
Ca ≥ 10 ppm	Mn ≥ 0.4 ppm	Ti ≥ 0.8 ppm
Co ≥ 2 ppm	Mo ≥ 4 ppm	V ≥ 1 ppm
Cr ≥ 4 ppm	Na ≥ 5 ppm	Zn ≥ 20 ppm
Cu ≥ 10ppm	Ni ≥ 4 ppm	Zr ≥ 0.3 ppm
Fe ≥ 20 ppm		

Requires a minimum sample weight of 20 g.

Note: Trace impurities are determined by lithium metaborate fusion with ICP-OES analysis on residue obtained by ashing (TM\_AMC561\_M). Additional impurity elements are available upon request. Graphitic carbon and impurity analysis are not available at all SGS locations, please enquire.

Iron Ore

Lithium borate fusion and WD XRF analysis is the industry method of choice for the analysis of oxide iron ores. Single or multi-temperature LOI is available, customizable as required. Borate Fusion ranges are available to accommodate ore grade, grade control and commercial analysis. High Magnetite containing iron ore will require oxidizing fusion (XRF76).

GO\_XRF72FE1 BORATE FUSION / XRF IRON ORE PACKAGE

Al <sub>2</sub> O <sub>3</sub> 0.01 - 100%	K <sub>2</sub> O 0.01 - 10%	Sn 0.01 - 1%
As 0.01 - 1%	MgO 0.01 - 100%	Sr 0.01 - 1%
Ba 0.01 - 1%	Mn 0.01 - 28%	TiO <sub>2</sub> 0.01 - 50%
CaO 0.01 - 40%	Na2O 0.01 - 2%	V 0.01 - 5%
Cl 0.01 – 1%	Ni 0.01 - 10%	Zn 0.01 - 1%
Co 0.01 – 5%	P 0.01 - 10%	Zr 0.01 - 1%
Cr <sub>2</sub> O <sub>3</sub> 0.01 - 10%	Pb 0.01 - 10%	LOI -10 – 100%*
Cu 0.01 - 5%	S 0.01 - 2%	
Fe 0.01 - 70%	SiO <sub>2</sub> 0.01 - 100%	

\*G\_PHY01V or G\_PHY02V

GO\_XRF72FE2 BORATE FUSION / XRF IRON ORE PACKAGE

ELEMENTS AND LIMIT(S)		
Al <sub>2</sub> O <sub>3</sub> 0.01 - 100%	Mn 0.001 - 28%	Zn 0.001 - 1%
As 0.001 - 1%	Na <sub>2</sub> O 0.005 - 2%	Zr 0.001 - 1%
Ba 0.001 - 1%	Ni 0.001 - 10%	LOI (1000°C) REQ*
CaO 0.01 - 40%	P 0.001 - 10%	LOI (650°C) Optional*
Cl 0.001 - 1%	Pb 0.001 - 10%	LOI (425°C) Optional*
Co 0.001 - 5%	SiO <sub>2</sub> 0.01 - 100%	LOI (371°C) Optional*
Cr <sub>2</sub> O <sub>3</sub> 0.001 - 10%	Sn 0.001 - 1%	LOI (105°C) REQ*
Cu 0.001 - 5%	S 0.001 - 2%	
Fe 0.01 - 70%	Sr 0.001 - 1%	
K <sub>2</sub> O 0.001 - 10%	TiO <sub>2</sub> 0.01 - 50%	
MgO 0.01 - 100%	V 0.01 - 5%	

\*G\_PHY01V or G\_PHY02V

VOLUMETRIC METHOD FOR IRON ORE

CODE	ELEMENT	LIMIT(S)	DESCRIPTION	MIN. SAMPLEWT.(g)
GC_CON08V	Fe	10 - 95%	Titration	0.25

Note: this method can be analyzed to party or umpire quality standards (GT).

The Satmagan test provides a measure of magnetic susceptibility on pulp samples, with results expressed as magnetic iron. The Davis Tube test, separates various magnetic mineral phases from non-magnetic components on a range of size fractions of crushed iron ore at various stages of mineral processing. This allows for mass and elemental balancing.

SGS offers various other magnetic separation techniques for separating ferromagnetic minerals from paramagnetic, diamagnetic and non-magnetic minerals, in tills, mineral sands and in mineral processing.

CODE(S)	TECHNIQUE	DESCRIPTION
G_PHY20V	Satmagan	Measures the total magnetic moment in a saturated magnetic field to determine the percentage of magnetic material present
G_PHY19V	Davis Tube	Separates and gravimetrically determines strongly magnetic particles from weak and non-magnetic particles





Limestone / Lime / Industrial Minerals / Cement / Clinker / Dolomite

Industry standard borate fusion XRF multielement method based on dried sample. LOI is required.

GC_XRF72LS		
ANALYTE	REPORTED AS	RANGE
Al	Al <sub>2</sub> O <sub>3</sub>	0.01 - 100%
As	As <sub>2</sub> O <sub>3</sub> Optional	0.01 - 5%
Ba	BaO	0.01 - 5%
Ca	CaO	0.1 - 100%
Cl	Cl Optional	0.01 - 1%
Co	Co <sub>3</sub> O <sub>4</sub> Optional	0.01 - 1%
Cr	Cr <sub>2</sub> O <sub>3</sub>	0.01 - 1%
Cu	CuO	0.01 - 1%
Fe	Fe <sub>2</sub> O <sub>3</sub>	0.01 - 50%
K	K <sub>2</sub> O	0.01 - 5%
Mg	MgO	0.01 - 100%
Mn	Mn <sub>3</sub> O <sub>4</sub>	0.01 - 10%
Na	Na <sub>2</sub> O	0.05 - 60%
Ni	NiO Optional	0.01 - 1%
P	P <sub>2</sub> O <sub>5</sub>	0.01 - 55%
Pb	PbO Optional	0.01 - 5%
Si	SiO <sub>2</sub>	0.01 - 100%
Sn	SnO <sub>2</sub> Optional	0.01 - 5%
S	SO <sub>3</sub>	0.025 - 60%
Sr	SrO	0.01 - 5%
Ti	TiO <sub>2</sub>	0.01 - 50%
V	V <sub>2</sub> O <sub>5</sub>	0.01 - 5%
Zn	ZnO	0.01 - 5%
Zr	ZrO <sub>2</sub>	0.01 - 5%
LOI (1000°C)*	LOI	-10 - 100%
Moisture (as received)		≥0.01%
*G_PHY01V or G_PHY02V		



Resistive Minerals / Tungsten Tin Ores / Concentrates

XRF method with high dilution borate fusion digest. Use GO\_XRF76WSN for any sulphide, or metal containing samples.

GO_XRF72WSN/GO_XRF76WSN		
Minimum sample 1g.		
ANALYTE	REPORTING AS	RANGE
Al	Al <sub>2</sub> O <sub>3</sub>	0.01 - 100%
As	As	0.01 - 1%
Ba	Ba	0.01 - 20%
Ca	CaO optional	0.01 - 40%
Co	Co	0.01 - 5%
Cr	Cr <sub>2</sub> O <sub>3</sub>	0.01 - 60%
Cu	CuO optional	0.01 - 5%
Fe	Fe <sub>2</sub> O <sub>3</sub>	0.05 - 100%
K	K <sub>2</sub> O	0.01 - 10%
Mg	MgO	0.05 - 50%
Mn	MnO	0.01 - 15%
Na	Na <sub>2</sub> O	0.1 - 10%
Nb	Nb <sub>2</sub> O <sub>3</sub>	0.01 - 25%
Ni	NiO optional	0.01 - 10%
P	P <sub>2</sub> O <sub>5</sub>	0.01 - 10%
Pb	PbO	0.01 - 5%
Si	SiO <sub>2</sub>	0.05 - 10%
Sn	SnO <sub>2</sub>	0.01 - 100%
S	SO <sub>3</sub>	0.01 - 2%
Sr	SrO	0.01 - 1%
Ta	Ta <sub>2</sub> O <sub>5</sub>	0.01 - 50%
Th	ThO <sub>2</sub> optional	0.01 - 1%
Ti	TiO <sub>2</sub>	0.01 - 50%
U	U <sub>3</sub> O <sub>8</sub> optional	0.01 - 5%
V	V <sub>2</sub> O <sub>5</sub> optional	0.01 - 5%
W	WO <sub>3</sub>	0.01 - 100%
Zn	ZnO	0.01 - 1%
Zr	ZrO <sub>2</sub>	0.01 - 1%
LOI (1000°C)*	LOI	-10 - 100%
Dried only		
*G_PHY01V or G_PHY02V		
Note: Additional grinding might be needed		





Uranium

SGS complies with all national licensing requirements associated with the safe handling and analysis of naturally occurring radioactive materials samples for transportation, workplace safety and environmental protection. The following analytical packages are specifically designed for uranium exploration and are offered at designated SGS laboratories. Multi-element packages are listed in the Exploration Grade Analysis section of this guide for low grade uranium analysis.

URANIUM PACKAGES FOR LOW GRADE MINERALIZATION

CODE(S)	ELEMENTS/ LIMIT(S)	DESCRIPTION
GE_IMS21B20	0.05 - 10,000 ppm	Aqua regia digest / ICP-MS
GE_IMS95A50	0.05 - 10,000 ppm	Lithium metaborate fusion / ICP-MS
GE_MMIME	≥0.5ppb	Mobile Metal Ion Technology™ for soils

Multi-element packages are listed in the Ore-Grade Analysis section of this guide. These methods are for medium to highly mineralized samples that include uranium analysis.

URANIUM PACKAGES FOR HIGHER GRADE MINERALIZATION

CODE(S)	ELEMENTS/ LIMIT(S)	DESCRIPTION
GO_IMS91Q100	1 - 200 ppm	Sodium peroxide fusion / ICP-MS
GO_XRF/EDX 71UTH	0.0008 - 0.36%	Pressed pellet/powder XRF
GO_XRF72	0.01 - 4.2%	Borate fusion / XRF

Control Grade Analysis

Customized Spectroscopic Analysis

The analytical approach for control analysis differs from the standard geochemistry “package” methodology. Instead, we provide both multi-element packages and customized spectroscopic determinations that can include multiple dilutions on an element-by-element basis to ensure that the interferences common in complex samples are identified and resolved.

These control assay methods are only a small selection of the methods and capabilities available at SGS. A wide variety of other methods are available including fire assay, manual and automated titrations, CVAA mercury analysis, AAS, IR combustion, coulometry and chromatography. Fire assay methods often require customized fluxes and finishes. Please contact us if you have any needs in this area – we have lots of expertise to share.

Two Acid/Aqua Regia Digestion Packages

GC\_ICP21C50 AQUA REGIA DIGESTION PACKAGE / ICP-OES

ELEMENTS AND REPORTING LIMIT(S)			
Ag ≥ 0.8 - 1000 ppm	Co ≥ 3 ppm	Mo ≥ 6 ppm	Sr ≥ 0.02 ppm
Al ≥ 2 ppm	Cr ≥ 1 ppm	Na ≥ 20 ppm	Ti ≥ 0.2 ppm
As ≥ 30 ppm	Cu ≥ 1 ppm	Ni ≥ 6 ppm	Tl ≥ 30 ppm
Ba ≥ 0.07 ppm	Fe ≥ 2 ppm	P ≥ 50 ppm	V ≥ 2 ppm
Be ≥ 0.02 ppm	K ≥ 10 ppm	Pb ≥ 20 ppm	Y ≥ 0.5 ppm
Bi ≥ 10 ppm	Li ≥ 20 ppm	Sb ≥ 10 ppm	Zn ≥ 7 ppm
Ca ≥ 20 ppm	Mg ≥ 0.7 ppm	Se ≥ 30 ppm	
Cd ≥ 0.9 ppm	Mn ≥ 0.4 ppm	Sn ≥ 20 ppm	

Additional elements can be added. An ICP-MS option is available. Requires a minimum sample weight of 1.0 g.





Multi-Acid (Four Acid) Digestion Packages

GC\_ICP42C100 MULTI-ACID DIGESTION PACKAGE / ICP-OES

ELEMENTS AND REPORTING LIMIT(S)			
Ag ≥ 2 ppm	Co ≥ 4 ppm	Mo ≥ 5 ppm	Sr ≥ 1 ppm
Al* ≥ 100 ppm	Cr* ≥ 10 ppm	Na ≥ 100 ppm	Ti* ≥ 5 ppm
As* ≥ 30 ppm	Cu ≥ 5 ppm	Ni ≥ 20 ppm	Tl ≥ 30 ppm
Ba* ≥ 2 ppm	Fe ≥ 100 ppm	P ≥ 30 ppm	V ≥ 2 ppm
Be ≥ 0.05 ppm	K* ≥ 20 ppm	Pb ≥ 20 ppm	Y ≥ 0.5 ppm
Bi ≥ 20 ppm	Li ≥ 10 ppm	Sb* ≥ 10 ppm	Zn ≥ 10 ppm
Ca* ≥ 100 ppm	Mg* ≥ 40 ppm	Se ≥ 30 ppm	
Cd ≥ 2 ppm	Mn ≥ 5 ppm	Sn* ≥ 20 ppm	

Additional elements can be added. An ICP-MS option, and option with fusion, are available. Requires a minimum sample weight of 1.0 g.

\*Recovery can be incomplete so analysis can be biased low.

GC\_ICP46C100 MULTI-ACID DIGESTION PACKAGE / FUSION / ICP-OES

ELEMENTS AND REPORTING LIMIT(S)			
Ag ≥ 2 ppm	Co ≥ 4 ppm	Mo ≥ 5 ppm	Sr ≥ 1 ppm
Al ≥ 100 ppm	Cr ≥ 10 ppm	Na ≥ 100 ppm	Ti ≥ 5 ppm
As* ≥ 30 ppm	Cu ≥ 5 ppm	Ni ≥ 20 ppm	Tl ≥ 30 ppm
Ba ≥ 2 ppm	Fe ≥ 100 ppm	P ≥ 30 ppm	V ≥ 2 ppm
Be ≥ 0.05 ppm	K ≥ 20 ppm	Pb ≥ 20 ppm	Y ≥ 0.5 ppm
Bi ≥ 20 ppm	Li ≥ 10 ppm	Sb* ≥ 10 ppm	Zn ≥ 10 ppm
Ca ≥ 100 ppm	Mg ≥ 40 ppm	Se ≥ 30 ppm	
Cd ≥ 2 ppm	Mn ≥ 5 ppm	Sn* ≥ 20 ppm	

Additional elements can be added. An ICP-MS option is available. Requires a minimum sample weight of 1.0 g.

\*Recovery can be incomplete so analysis can be biased low.

Fusion Packages

GC\_ICP93A50V FUSION / ICP-OES PACKAGE

ELEMENTS AND REPORTING LIMIT(S)			
Ag 200 ppm - 1 %	Co 200 ppm - 50%	Mo 300 ppm - 50%	Tl 2,000 ppm - 50%
Al 0.04% - 50%	Cr 200 ppm - 50%	Ni 300 ppm - 50%	V 80 ppm - 50%
As 1,200 ppm - 50%	Cu 40 ppm - 50%	Pb 800 ppm - 50%	Y 8 ppm - 50%
Ba 3 ppm - 50%	Fe 0.05% - 50%	Sb 400 ppm - 50%	Zn 300 ppm - 50%
Be 3 ppm - 50%	K 0.04% - 50%	Se 2,000 pm - 50%	
Bi 400 ppm - 50%	Li 800 ppm - 50%	Sn 800 ppm - 50%	
Ca 0.1% - 50 %	Mg 0.003% - 50%	Sr 10 ppm - 50%	
Cd 40 ppm - 50%	Mn 0.002% - 50%	Ti 0.02% - 50 %	

Additional elements can be added. An ICP-MS option is available. Requires a minimum sample weight of 0.2 g.

GC\_AAS93A50V FUSION / AAS

ELEMENTS AND REPORTING LIMIT(S)			
Al ≥ 0.02 %	Fe ≥ 0.07 %	Si ≥ 0.07 %	V ≥ 0.1 %
Ca ≥ 0.06 %	Mg ≥ 0.005 %	Sn ≥ 0.05 %	Zn ≥ 0.001 %
Cr ≥ 0.005 %	Mn ≥ 0.005 %	Ti ≥ 0.05 %	

Additional elements can be added. An ICP-MS option is available. Requires a minimum sample weight of 0.2 g. Concentrate samples containing greater than 50% of the target element can require alternative analytical methods if full recovery is required.

FUSION / XRF CONTROL-GRADE PACKAGES

CODE(S)	ELEMENTS / LIMIT(S)	DESCRIPTION
GC_XRF72	Same available range and elements as GO_XRF72, refer to ore grade analysis section	Borate fusion / XRF
GC_XRF70V	Same available range and elements as GO_XRF70V, refer to ore and commodities section	Pyrosulphate fusion / XRF



Process Solution Packages

GC\_ICP84T PROCESS SOLUTION PACKAGE / ICP-OES / NON-CYANIDE BASED

ELEMENTS AND REPORTING LIMIT(S)			
Ag ≥ 0.08 ppm	Co ≥ 0.3 ppm	Mo ≥ 0.6 ppm	Sr ≥ 0.002 ppm
Al ≥ 0.2 ppm	Cr ≥ 0.1 ppm	Na ≥ 2 ppm	Ti ≥ 0.02 ppm
As ≥ 3 ppm	Cu ≥ 0.1 ppm	Ni ≥ 0.6 ppm	Tl ≥ 3 ppm
Ba ≥ 0.007 ppm	Fe ≥ 0.2 ppm	P ≥ 5 ppm	V ≥ 0.2 ppm
Be ≥ 0.002 ppm	K ≥ 1 ppm	Pb ≥ 2 ppm	Y ≥ 0.02 ppm
Bi ≥ 1 ppm	Li ≥ 2 ppm	Sb ≥ 1 ppm	Zn ≥ 0.7 ppm
Ca ≥ 0.9 ppm	Mg ≥ 0.07 ppm	Se ≥ 3 ppm	
Cd ≥ 0.09 ppm	Mn ≥ 0.04 ppm	Sn ≥ 2 ppm	

Additional elements can be added. Requires a minimum sample volume of 10 mL. ICP-MS option may be available locally.

Please enquire.

GC\_ICP82T PROCESS SOLUTION PACKAGE / ICP-OES / CYANIDE BASED

ELEMENTS AND REPORTING LIMIT(S)			
Ag ≥ 0.08 ppm	Co ≥ 0.3 ppm	Mo ≥ 0.6 ppm	Sr ≥ 0.002 ppm
Al ≥ 0.2 ppm	Cr ≥ 0.1 ppm	Na ≥ 2 ppm	Ti ≥ 0.02 ppm
As ≥ 3 ppm	Cu ≥ 0.1 ppm	Ni ≥ 0.6 ppm	Tl ≥ 3 ppm
Ba ≥ 0.007 ppm	Fe ≥ 0.2 ppm	P ≥ 5 ppm	V ≥ 0.2 ppm
Be ≥ 0.002 ppm	K ≥ 1 ppm	Pb ≥ 2 ppm	Y ≥ 0.02 ppm
Bi ≥ 1 ppm	Li ≥ 2 ppm	Sb ≥ 1 ppm	Zn ≥ 0.7 ppm
Ca ≥ 0.9 ppm	Mg ≥ 0.07 ppm	Se ≥ 3 ppm	
Cd ≥ 0.09 ppm	Mn ≥ 0.04 ppm	Sn ≥ 2 ppm	

Additional elements can be added. Requires a minimum sample volume of 10 mL. ICP-MS option may be available locally.

Please enquire.

INDIVIDUAL METHODS FOR CONTROL-GRADE ANALYSIS

SULPHUR AND CARBON

CODE(S)	ELEMENT	LIMIT(S)	DESCRIPTION	MIN. SAMPLE WT.(g)
GC_CSA06V	S	≥ 0.01 %	IR combustion	0.1 - 0.3
	C	≥ 0.01%		0.1 - 0.3
GC_CSA08V	S <sup>2-</sup>	≥ 0.05%	Leach/Digest/IR	2.0
GC_CLA01V	Fe <sup>2+</sup>	≥ 0.5%	Ferrous iron titration	0.25

Single elements can be determined by numerous decomposition techniques and finishes. Please contact your local laboratory for options.

ADDITIONAL SINGLE ANALYTES

CODE(S)	ANALYTES	LIMITS	DESCRIPTION	MIN. SAMPLEWT.(g)
GC_CLA04V	Insolubles (acid)	≥ 0.05%	Gravimetric	1
GC_CLA03V	CaO	≥ 5%	Available lime	2
GC_CVA38B50	Hg	≥ 0.3 ppm	Cold vapour AAS	0.25
GC_ISE10V	pH (soils/sediments)	0.1 - 14	Ion selective electrode	20

SGS can analyze a number of individual ore-grade elements. Please enquire.

VOLUMETRIC AND GRAVIMETRIC METHODS FOR CONCENTRATES

CODE(S)	ELEMENT	LIMIT(S)	DESCRIPTION	MIN. SAMPLE WT.(g)
GC_CON13V	Cu	15 - 60%	Titration	0.25
GC_CON03V	Cu	5 - 95%	Electroplating	1.0
GC_CON07V	Ni	5 - 100%	Electroplating	1.0
GC_CON11V	Pb	10 - 80%	Titration	2.0
GC_CON12V	Zn	10 - 80%	Titration	0.5
GC_CON08V	Fe	10 - 95%	Titration	0.25

Note: these elements can be analyzed to party or umpire quality standards (GT). Additional elements can be determined on concentrate samples in some SGS laboratories. Please enquire. Trade sample analyzes typically require moisture analysis and may require a larger minimum sample weight.





## FOCUS ON

# Field Analytical Services & Testing ("FAST")

SGS FAST solutions provide you with efficient and essential analytical data to keep you fully informed and up-to-date. This allows you to make important business decisions, keep your stakeholders informed and meet regulatory requirements, e.g., JORC compliance.

We tailor our solutions to the commodity of interest, and the client's needs, using a suite of portable state-of-the-art technologies. The current set of FAST portable analytical technologies generate both chemical and mineralogical data and will be continually updated and augmented with new technologies as they become available or as new industry testing requirements are identified.

The FAST services currently offered globally are:

- WD-XRF Core Scanning systems.
- Portable XRF analysis systems (pXRF).
- FTIR analysis systems (FTIR).

- Machine learning and advanced data analysis Portable XRF (pXRF) (Chemistry / Elemental analysis).

Our measurements are accurate, and we can even reprocess historical measurement data to further increase data quality and additional elements can also be added. The application is continuously checked by performing confirmation analysis on 5-20% of the site samples at an SGS commercial Laboratory. This confirmation analysis can also be used to improve a generic calibration to a site-specific calibration.

Precious metals, Au, Pt, Pd and Rh are not available using this technique as they can be highly biased due to interelement and matrix effects that cannot be removed. Please enquire.

More information can be found at [www.sgs.com/FAST](http://www.sgs.com/FAST).

## Exploration Grade XRF Analysis

PXRF on exploration grade pulp can be readily added to acid partial digest ICP methods (as above) to include resistive minerals and total recovery of Ti, Zr, Sn, W, Nb, and Ta.

### GE\_PXRF73GEO SOIL EXPLORATION PXRF PACKAGE

GEO is for the pulp based measurement for rocks, sediments as well as RC drill cuttings, crushed core for litho geochemistry; SOIL is for delumped soil samples < 180 microns.

#### ELEMENTS AND LIMIT(S)

Ag* 0.005 - 0.01 %	Hg* 0.005 - 0.1 %	Sn* 0.01 - 1 %
Al 0.2 - 45%	K 0.02 - 5%	Sr 0.0005 - 0.5%
As 0.001 - 2%	La* 0.02 - 0.4%	Ta* 0.005 - 0.1 %
Ba 0.05 - 0.4%	Mg* 2.5 - 45%	Th 0.002 - 0.1 %
Bi* 0.005 - 0.1 %	Mn 0.06 - 3.2%	Ti 0.02 - 2.5%
Ca 0.05 - 32%	Mo 0.005 - 0.05%	Tl* 0.002 - 0.02 %
Cd* 0.005 - 0.5%	Nb* 0.005 - 1 %	U 0.002 - 0.1 %
Ce* 0.02 - 1 %	Ni 0.005 - 1 %	V 0.01 - 0.2%
Cl* 0.03 - 2%	P 0.05 - 14.5%	W* 0.005 - 0.1 %
Co 0.005 - 0.3%	Pb 0.001 - 2 %	Y 0.0005 - 0.2%
Cr 0.01 - 1.5%	Rb 0.0005 - 0.05%	Zn 0.002 - 0.8%
Cu 0.0015 - 3%	S 0.02 - 15%	Zr 0.0005 - 1 %
Fe 0.01 - 28%	Sb* 0.01 - 1 %	
Ga* 0.005 - 0.5%	Se* 0.001 - 0.01%	
Hf* 0.005 - 1 %	Si 0.5 - 47%	

\* Optional elements with indicative value only unless extra QC is added at extra cost per element/site specific.

### GE\_PXRF73CONC MINING MATERIALS CONCENTRATES/PRODUCT

Pulp measured through a paper or plastic bag or as powder mount. Indicative results reported and adjusted for attenuation of the bag when used. Elements common with bag material (i.e., Ca, Ti and Zn) are not reportable. Requires matrix matched quality control samples. Charged on per element basis.

#### ELEMENTS AND LIMIT(S)

As* 0.005 - 10%	Fe 0.5 - 77%	Sn* 0.1 -89%
Ba* 0.1 - 10%	Mn 0.5 - 80%	Ta* 0.1 - 82%
Bi* 0.01 - 90%	Ni 0.2 - 80%	W* 0.1 - 80%
Ca 0.5 - 35%	Pb 0.1 - 94%	Zn* 0.1- 85%
Cr* 0.5 - 69%	S* 0.5 - 30%	Zr* 0.1 - 74%
Cu 0.1 - 85%	Sb* 0.1 - 56%	

\* Optional elements may be available at select locations with an additional Quality Control setup cost, otherwise indicative assay only. Please enquire.

### GE\_PXRF73MIN

Pulp based measurement for mineralized rocks, sediments, RC drill cuttings, crushed core, feeds and concentrates in a loose powder setup.

#### ELEMENTS AND LIMIT(S)

Ag* 0.001 - 0.6%	Hf* 0.001 - 72%	Si 0.1 - 47%
Al 0.1 - 35%	Hg* 0.002 - 86%	Sn 0.005 - 88%
As 0.0005 - 50%	K 0.009 - 10%	Sr 0.0005 - 1 %
Ba 0.003 - 10%	La* 0.004 - 0.7%	Ta* 0.003 - 82%
Bi* 0.0005 - 90%	Mg* 0.3 - 35%	Te* 0.001 - 0.02%
Ca 0.004 - 31%	Mn 0.002 - 45%	Th* 0.001 - 0.5%
Cd* 0.001 - 0.7%	Mo 0.001 - 67%	Ti 0.004 - 60%
Ce* 0.0015 - 4.5%	Nb 0.001 - 42%	Tl* 0.0005 - 0.02%
Cl* 0.01 - 4%	Ni 0.001 - 80%	U* 0.001 - 0.1 %
Co* 0.001 - 72%	P 0.01 - 13%	V 0.004 - 56%
Cr 0.003 - 28%	Pb 0.0005 - 93%	W* 0.001 - 80%
Cs* 0.003 - 18%	Rb 0.0005 - 0.07%	Y 0.0005 - 0.2%
Cu 0.0005 - 80%	S 0.01 - 41%	Zn 0.0005 - 80%
Fe 0.003 - 70%	Sb 0.005 - 19%	Zr 0.0005 - 39%
Ga* 0.0005 - 0.05%	Se 0.0005 - 0.05%	

\* Optional elements with indicative value only unless extra QC is added at extra cost per element/site specific.





## Optimizing Mine Efficiency Through Reliable Data

Efficient and financially viable mining operations require accurate and reliable data to help managers optimize their processes and ensure contractual and regulatory compliance.

With a global network of specialists, we are ready to help support you with advanced on-site geochemical analysis. From exploration to operation, our on-site teams provide data that will help you gain the high-level insights you need to make informed management decisions. Our services allow you to fine-tune every stage of your value chain with solutions that support exploration, mining, mill and plant operations, smelting, and tailings disposal.

These include:

- Exploration & mine support
- Mill & plant support
- Smelter support
- Hybrid laboratories
- Mobile Sample Preparation Units (MSPU)

Our services can be customized to your individual requirements and are delivered by industry recognized experts. Whatever your requirements and wherever you operate, we can help you to develop and implement the right on-site laboratory for your operation.



FOCUS ON ↓

## Mobile Sample Preparation Units (MSPU)

SGS mobile sample preparation units promote fast sample preparation turnaround times prior to being submitted for geochemical or assay data, needed to effectively run and optimize your exploration or mine development project. Various models of the SGS MSPU are available depending on the project location, climate, sample size, preparation protocol and required sample throughput.

We install state-of-the-art equipment in all MSPU operations. Equipment is selected based on our unmatched experience operating remotesite laboratories. All equipment used is selected for its robustness, ease of repair and adherence to the highest HSE industry standards.

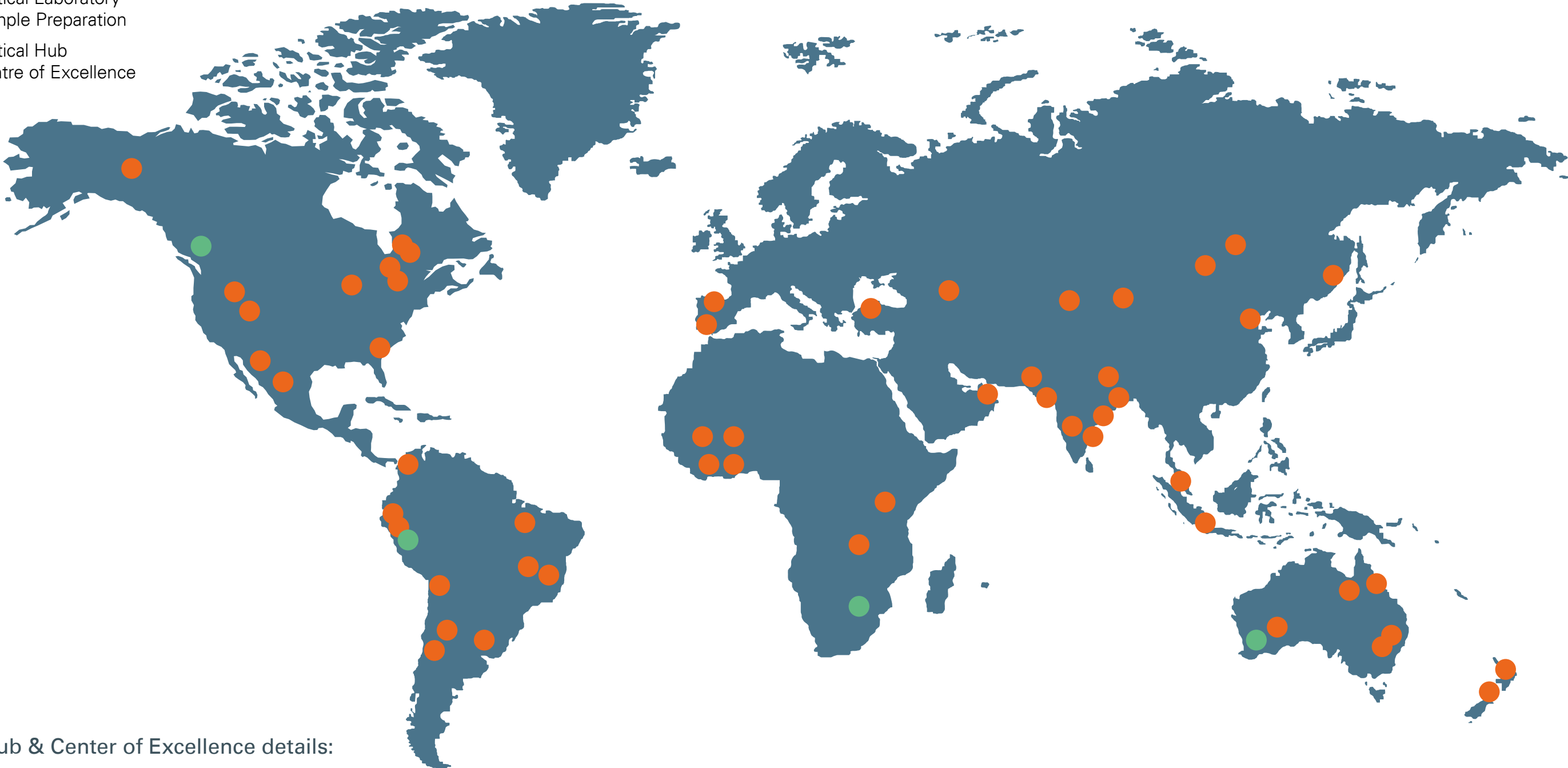






# Geochemistry Commercial Laboratories Map

- Analytical Laboratory  
& Sample Preparation
- Analytical Hub  
& Centre of Excellence



SGS Hub & Center of Excellence details:

**SGS Canada**  
3260 Production Way  
Burnaby V5A 4W4  
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**SGS South Africa**  
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Randfontein 1760  
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**SGS Australia**  
28 Reid Road  
Newburn WA 6105  
+61 8 9373 3640

[naturalresources@sgs.com](mailto:naturalresources@sgs.com)





## Annexes



### SGS Code of Integrity

The SGS Code of Integrity has been approved by our Board of Directors and the Operations Council. It applies to all of our employees, officers and directors and our affiliated companies.

All aspects of the Code which are not specifically related to our employees must also be adhered to by contractors, consultants, freelancers, joint-venture partners, agents, subcontractors and anyone acting on behalf of, or representing, SGS.

The Code defines the main principles of professional integrity and is an expression of the values that are shared throughout SGS, our various businesses and our affiliates. Referring to it should help anyone acting for SGS to make the correct decisions while carrying out their work.

Our code of integrity obliges us to :

- Behave with integrity and responsibly
- Abide by the rules, laws and regulations of the countries we are operating in
- Encourage us to speak up and be confident enough to raise concerns and consider any that are brought to us

SGS Code of Integrity is available in 30 languages on our [website](#).





## SGS Quality & Professionalism

SGS strives to build mutually beneficial partnerships. By focusing on continuous improvement and operational excellence we ensure the long-term sustainability of our business and high levels of customer satisfaction. Our aim is to:

- Develop and maintain the processes we need to deliver high quality, optimized and coherent services
- Build strong customer relationships based on trust, mutual respect, and the prioritization of their needs
- Respect customer confidentiality and individual privacy while remaining transparent in all other aspects of our work
- Be known and recognized for our expertise, reliability, quality, and consistency
- Nurture and encourage a culture of quality and professionalism within SGS, with full support of management and engagement of all employees

It is therefore our commitment to:

- Maintain flexibility, listen to both industry and customer needs and expectations
- Continuously challenge ourselves by reviewing and improving our quality objectives and performance indicators to lower risks and raise customer satisfaction levels
- To use methods which are suitably validated, fit-for-purpose and based on internationally recognized methods when possible
- Measure, maintain and increase our knowledge base through sustainable processes of talent recruitment, employee training and retention
- Recognize and protect our intellectual property, intelligence and embody the SGS brand

At SGS delivering quality and professionalism is an individual responsibility for all of us, at every level within our organization. These commitments apply to all SGS employees and contractors. Management is responsible for ensuring full compliance with SGS policies.

Our laboratories operate with a Quality Management System that strives to provide customer satisfaction by ensuring that all quality policies and procedures are documented, clearly demonstrated, monitored, accessible and followed. Quality Management personnel supervise and ensure the system is proactively and continuously monitored. This allows us to react promptly to fluctuations in performance.

SGS laboratories follow a global procedure to select appropriate quality control materials, insertion frequency and appropriate acceptance and rejection data criteria for each of our methods. Data is monitored both on a short-term and long-term continuous basis. Customer specific reports are generated with our SLIM (SGS Laboratory Information Management) system and are readily available.

Please see our Laboratory Quality Control Summary on our [Geochemistry webpage](#) for more details on these procedures. While we have proven methodologies with strong quality control procedures, SGS recognises that not all analytical problems can be solved with routine methodology. We value close communication with you, not only to address individual sample situations, but to address the issues confronted by the minerals industry. SLIM is used as part of our global quality control platform and is used by over 300 SGS minerals analytical laboratories. It controls procedures and methodology, data management and reporting, quality control and governing activities, service attitudes and responses. As a result, you can rest assured that you will receive a uniform and standardized response from any SGS Laboratory worldwide. You can trust us and rely upon us anywhere in the world.





## SGS Submissions Forms

Our sample submission forms are available in English, French and Spanish. They are available on the website in an editable format for you to complete. If you have any questions about the form, please contact your local SGS sales representative.

Click here for **English**

Click here for **French**

Click here for **Spanish**

## By your side at all times

SGS is trusted as the world's leading testing, inspection and certification company. We have the global reach and local knowledge to help you achieve your goals within agreed timelines. Whatever your requirements, and wherever you operate, our geochemistry team is ready to help you.

We are SGS - we bring trust and integrity to your supply chain, and help protect your business globally.

Contact us today and take the first step towards creating an easier, more effective approach to optimize your projects.





# Trusted. Independent. Committed.

## Contact Us

[naturalresources@sgs.com](mailto:naturalresources@sgs.com)

[www.sgs.com/geochemistry](http://www.sgs.com/geochemistry)

[www.sgs.com/linkedin-natural-resources](http://www.sgs.com/linkedin-natural-resources)

The SGS logo consists of the letters "SGS" in a bold, sans-serif font. A vertical line is positioned to the right of the letters, and a horizontal line is positioned below the letters, forming an L-shape around the text.

WHEN YOU NEED TO BE SURE