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October 17, 2022

Dr. Eric L. Hoffman

A Tribute to
Dr. Eric Laurence Hoffman

Eric Laurence Hoffman, Ph.D, P.Geo, President and founder of Activation Laboratories Ltd. (Actlabs), passed away on July 10, 2015.

Eric was an economic geologist with over 30 years of experience in minerals exploration, analysis, and management. In 1974, he received his Bachelor of Science (Hons.) in Geology and his Masters of Science in Geology in 1975, both from McGill University. He received his Ph.D. in Geology from the University of Toronto in 1978 and became a registered Professional Geoscientist (P.Geo) in Ontario in 2002.

In 1978 at the young age of 35, he established Nuclear Activation Services Ltd., a partnership with McMaster University and the first commercial instrumental neutron activation laboratory in the world. In 1987, Eric established Activation Laboratories Ltd. (Actlabs) Group of Companies with a focus on commercializing innovative technologies with the highest quality standards to the minerals, metallurgy, petroleum, life sciences, environmental, forensics, materials testing, and agriculture industries, achieving global success by building and running a company with 21 laboratories and 1000 employees in 10 countries. In 2014, Actlabs new 200,000 sq. ft. global headquarters was officially opened, a milestone for Actlabs growth and a symbol of how much he accomplished.

Eric received many honours and awards, including a 1971-72 JW McConnell Undergraduate Scholarship, a 1972-73 RPD Graham Undergraduate Scholarship; a 1973-74 Logan Undergraduate Scholarship; the 1974 Logan Gold Medal in Geology for Highest Standing and graduated with First Class Honours with Great Distinction; 1974-75, 1975-76, 1976-77, and 1977- 78 National Research Council of Canada Postgraduate Scholarships; 1978-79 and 1979-80 NRC Post-Doctoral Industrial Fellowships; a 2009 Canadian Innovation Leader award from Government of Canada, and the 2013 Gold Medal from the Association of Applied Geochemists. The AAG Gold Medal was awarded in recognition of Eric's career as an industry leader in bringing novel analytical techniques to commercial fruition. He anticipated the evolving needs of the applied geochemist through technique design and instrument modification for a wide variety of sample media – key to longer term success as exploration has moved into progressively more difficult concealed terranes.

Eric was greatly admired and deeply respected by all who knew him. He was an excellent businessman, a great innovator, a valuable contributor to the geochemistry community, a champion of geochemical research, and an icon of the Canadian mineral exploration scene. Eric published consistently throughout his career, was always in attendance at scientific meetings to present and promote the latest in techniques and instrumentation in geochemical exploration. In addition to his close work with industry, hundreds of research papers in the peer-reviewed literature bear the mark of Actlabs' contributions and Eric's direct input. He was a strong supporter and sponsor of collaborative industry-university research projects in Canada and abroad. He will be missed by all who interacted with him for his drive and energy.

The Actlabs Team is committed to carrying-on Eric's dream and ensuring the success of Actlabs. We've put in place plans to ensure that the company stays strong and thriving, especially through these depressed times in the industry. We will continue to provide industry leading high quality analyses and innovative technologies as this is what Eric would have wanted.

A Memorial Scholarship at the University of Toronto was established in his memory. This Earth Sciences graduate scholarship will be able to help future students advance a field that Eric was so passionate about.

We miss him a lot, but his memory will never be forgotten and his legacy will live forever.

General Information

Sample Packaging & Shipping Instructions

We offer the following basic advice to help ensure your samples arrive at the lab safely and to avoid processing delays and possible additional charges for sorting:

- clearly identify samples with a unique identification number or name using waterproof ink on the sample bags and/or sample tags in the sample bags
- securely package all samples and place them in your shipping containers (e.g. bags, pails or boxes) in order
- sealed plastic bags are best for shipping pulps
- if using pop top vials or glass bottles, ensure that they are taped shut and protected from breakage
- fill out a Request for Analysis Form (available from www.actlabs.com) as completely a possible and submit it with each batch of samples (including the carrier or shipment method and the waybill number on the form will allow us to track delayed shipments if necessary)
- clearly identify all shipping containers with your contact information, the destination address, and sequential number
- place hardcopies of the Request for Analysis Form and a sample list in the first shipping container, and email digital copies to your destination lab (Actlabs' receiving locations and general email addresses are listed on page 40)
- before shipping soils or vegetation samples from outside Canada to Actlabs in Canada, contact us for specific labelling and shipping instructions to avoid border delays
- this is not an exhaustive list, so please contact us with any questions, or to discuss your project requirements, as we are happy to help

Actlabs provides the following sampling supplies on request:

- complimentary shipping labels and sample tags
- poly-weave shipping bags, heavy duty plastic sample bags, cable ties, and soil envelopes are available for a fee

Quality Statement

Quality Assurance and Quality Control (QA/QC) is an integral aspect of our analyses and is a key component to Actlabs' vision, strategy and mission. Actlabs' Quality System monitors all steps and phases of our operations. Our Quality System outlines comprehensive details concerning our facilities, personnel qualifications, and processes used. Additionally, we are routinely audited by four regulatory agencies that focus on continual improvement. As a result, we continue to raise the bar with respect to the quality of our services in order to exceed their expectations and those of our clients.

Actlabs' Quality System is registered to international quality standards through the International Organization for Standardization / International Electrotechnical Commission (ISO/IEC) 17025:2017 (including ISO 9001:2015 and ISO 9002 specifications). Actlabs is accredited to the Standards Council of Canada (SCC) Requirements and Guidance for the Accreditation of Testing Laboratories, specific to mineral, forensic and environmental testing laboratories. The accreditation program includes ongoing audits which verify the Quality Management System and all applicable accredited test methods.

Report Formats

All reports and invoices will be emailed in PDF format and data sent in a digital format such as Excel or CSV to the email addresses that you specify on the Request for Analysis Form submitted with the samples. Custom report formats are also available so please contact us to discuss your specific requirements. Hard copies of reports or invoices are only available by special request and may incur additional cost.

Turnaround Time

Actlabs defines Turnaround Time (TAT) as the time from receiving a batch of samples at our laboratory with clear identification and analysis instructions, until we report the analysis results to you.

Routine TAT for a batch of samples depends on the number of samples, the preparation and analysis methods required, and current laboratory workloads; therefore, TAT may be variable based on the sample batch and the time of year submitted. Also, excessively wet samples or undocumented and / or unorganized shipments may slow down TAT. Contact us for a TAT estimate based on your planned project specifics or when you submit a batch of samples.

Priority or Rush TAT may be available depending on current laboratory workloads. If you require analysis results by a certain date, contact us to discuss your requirements before submitting the samples so we can confirm availability and what price surcharge is applicable. Once we have agreed on an estimated rush TAT, your samples will be prioritised, we will make every effort to report your results as close as possible to the agreed due date, and the agreed price surcharge will be applied.

WebLIMS

Clients can track their sample status from reception through logging, preparation, analysis and reporting, and access their final analysis results on-line, via secure login to our WebLIMS system. Please contact customerservice@actlabs.com to establish a WebLIMS account for your project.

For International Samples into Canada - Waybill Instructions: Mineral Samples for Analysis, No Commercial Value. Value for Customs: US$5.00. Canadian Customs Tariff (Harmonized Code) 2617.90.00.00. Customs Broker: Thompson Ahern & Co Ltd.

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Sample Preparation

To obtain meaningful analytical results, it is imperative that sample collection and preparation be done properly. Actlabs can advise on sampling protocol for your field program if requested. Once the samples arrive in the laboratory, Actlabs will ensure that they are prepared properly. As a routine practice with rock and core, the entire sample is crushed to a nominal -2 mm, mechanically split to obtain a representative sample and then pulverized to at least 95% -105 microns (µm). All of our steel mills are mild steel and do not introduce Cr or Ni contamination. Quality of crushing and pulverization is routinely checked as part of our quality assurance program. Samples submitted in an unorganized fashion will be subject to a sorting surcharge and may substantially slow turnaround time. Providing an accurate detailed sample list by e-mail will also aid in improving turnaround time and for Quality Control purposes.

Rock, Core and Drill Cuttings		
Code	**Description**	**Price**
RX1	Dry, crush (< 7 kg) up to 80% passing 2 mm, riffle split (250 g) and pulverize (mild steel) to 95% passing 105 µm included cleaner sand	$11.05
RX1-ORE	Dry, crush up to 90% passing 2 mm	add $2.00
RX1+500	500 grams pulverized	add $1.15
RX1+800	800 grams pulverized	add $2.10
RX1+1000	1000 grams pulverized	add $2.60
RX1-SD	Dry, crush (< 7 kg) up to 80% passing 2 mm, rotary split (250 g) and pulverized (mild steel) to 95% passing 105µm	$10.80
RX1-SD-ORE	Dry, crush up to 90% passing 2 mm	add $2.00
RX3	Oversize charge per kilogram for crushing	$1.15
RX4	Pulverization only (mild steel) (coarse pulp or crushed rock) (< 800 g)	$7.00
RX5	Pulverize ceramic (100 g)	$18.90
RX6	Hand pulverize small samples (agate mortar & pestle) (<5g)	$18.90
RX7	Crush and split (< 7 kg)	$5.20
RX8	Sample prep only surcharge, no analyses	$5.15
RX9	Compositing (per composite) dry weight	$4.20
RX10	Weight (kg) as received	$2.00
RX11	Checking quality of pulps or rejects prepared by other labs and issuing report	$9.90
RX14	Core cutting	On Request
RX15	Special Preparation/Hour	$72.00
RX16	Specific Gravity on Core	$13.85
RX16-W	Specific Gravity (WAX) on friable samples	$19.80
RX17	Specific Gravity on the pulp	$16.05
RX17-GP	Specific Gravity on the pulp by gas pycnometer	$17.00
RX18	Subsample split for 3rd party (up to 1kg)	$3.10

Note: Larger sample sizes than listed above can be pulverized at additional cost.

Our Sample Preparation pricing is all-inclusive including: sorting, drying, labeling, new reject bags, using cleaner sand between each sample and crushing samples up to 7 kg.

Soils, Stream and Lake Bottom Sediments, and Heavy Minerals		
Code	**Description**	**Price**
S1	Drying (60°C) and sieving (-177 µm) save all portions	$4.30
S1 DIS	Drying (60°C) and sieving (-177 µm), discard oversize	$4.05
S1-230	Drying (60°C) and sieving (-63 µm), save oversize	$5.40
S1-230 DIS	Drying (60°C) and sieving (-63 µm), discard oversize	$4.95
S2	Lake bottom sediment preparation crush & sieve (-177 µm)	$8.35
S3	Alternate size fractions and bracket sieving, add	$2.70
S4	Selective Extractions drying (40°C) & sieving (-177 µm)	$4.05
SGH-1	SGH drying (40°C) & sieving (-177 µm)	$4.05
S5	Wet or damp samples submitted in plastic bags, add	$2.00
S8	Sieve analysis (4 sieve sizes) coarser than 53 µm	$76.50
S9	Particle size analysis (laser)	On Request

All soil, sediment and vegetation samples received from outside Canada require incineration prior to disposal under Canadian Food Inspection Agency (CFIA) regulations so incineration charges will apply as listed in the table below

Sample Preparation Packages

Humus and Vegetation		
Code	**Description**	**Price**
B1	Drying and blending humus	$5.45
B2	Drying and macerating vegetation	$7.20
B3	Dry ashing	$9.90
B4	Washing vegetation	$4.95
B5	Samples submitted in plastic bags, add	$2.20

Special Digestion Procedures		
MDI	**Microwave digestion - closed vessel**	**On Request**

Sample Return, Disposal, and Storage

Please indicate on your Request for Analysis Form if your samples should be returned, disposed, or stored after analysis. Material is stored free of charge for a limited time after the date the final report is issued. If no instructions are received for sample return or storage, Actlabs reserves the right to dispose of the material after 3 months and disposal charges will apply. Material stored long-term will be subject to storage charges, billed quarterly. For returns, please include all necessary shipping information e.g., courier, account number, etc.

Irradiated material will be discarded 30 days after analysis unless prior arrangements are made. Return of radioactive material requires a Nuclear Safety Commission license. The cost per shipment of radioactive materials is $180.00 plus shipping costs.

Code	Description	Price
RTRN	Return of all reject portions and/or pulps	At cost +15%
INCIN	Incineration of soil, sediment and vegetation samples from outside Canada (for samples up to 0.5 kg; samples over 0.5 kg will add $0.35/kg)	$0.70
H&R	Handling and retrieval of stored sample material	$ 58.50/hour
DISP1	Disposal of pulps to landfill site	$0.25
DISP2	Disposal of reject to landfill site	$0.85
STORE 1	Monthly storage of reject after 60 days	$0.45
STORE 2	Monthly storage of pulps after 90 days	$0.25
STORE 3	Monthly storage of sieve rejects after 3 months	$0.25

Precious Metals Analysis

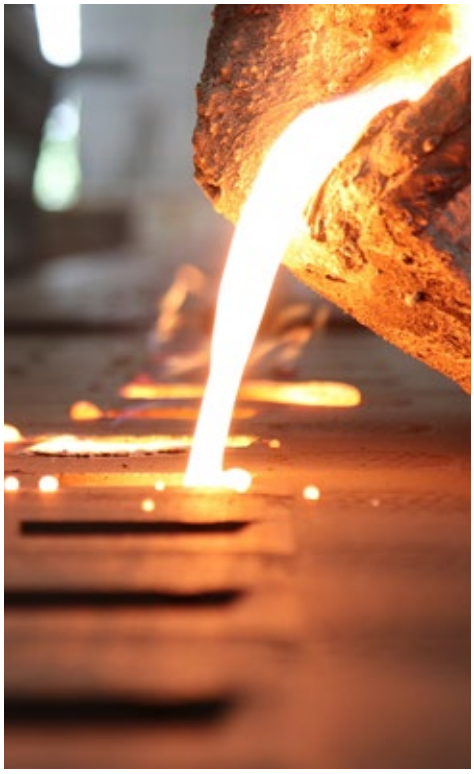
Gold and Silver Analyses - Geochem				
Code	Method	Sample Weight (g)	Metric Range (ppb)	Price
1A1	Au Fire Assay – INAA	30	1 – 20,000	$19.80
1A2	Au Fire Assay – AA	30	5 – 5,000	$17.00
1A2B-30	Au Fire Assay – AA	30	5 – 10,000	$18.15
1A2-50	Au Fire Assay – AA	50	5 – 5,000	$19.55
1A2B-50	Au Fire Assay – AA	50	5 – 10,000	$20.70
1A2-ICP	Au Fire Assay – ICP-OES	30	2 – 30,000	$18.40
1A2-ICP-50	Au Fire Assay – ICP-OES	50	2 – 30,000	$20.70
1A2-ICPMS	Au Fire Assay - ICP-MS	30	0.5 - 30,000	$25.20
1A6	Au BLEG - ICP-MS	1,000	0.1 - 10,000	$40.25
1A6-50	Au Cyanide Extraction - ICP-MS Ag or Cu add-on, for each additional, add	50	0.02 - 1,000	$14.85 $4.95
1A8-Au	Au Aqua Regia - ICP-MS	30	0.2 - 2,000	$18.00
1E-Ag	Ag Aqua Regia - ICP-OES	0.5	0.2 - 100 ppm	$7.65

Use of 50g sample for fire assay may not provide optimum recovery.
For proper fire assay fusion, Actlabs may reduce the sample weights to 15g or smaller at its discretion

Gold and Silver Analyses - Assay				
Code	Method	Sample Weight (g)	Metric Range (g/T)	Price
1A3-30	Au Fire Assay - Gravimetric	30	0.03 - 10,000	$22.50
1A3-50	Au Fire Assay - Gravimetric	50	0.02 - 10,000	$25.45
1A3-Ag (Au, Ag)	Au, Ag Fire Assay - Gravimetric	30	0.03 - 10,000 (Au) 3 - 10,000 (Ag)	$27.70
1A4 *	Au Fire Assay - Metallic Screen	500	0.03 – 10,000	$72.00
1A4-1000 *	Au Fire Assay - Metallic Screen	1,000	0.03 – 10,000	$81.90
8-Ag	Ag Fire Assay – Gravimetric	30	3 - 10,000	$24.75

* A representative 500 gram or 1000 gram (or customized) sample split is sieved at 149µm, with assays performed on the entire +149 µm fraction and two splits of the -149 µm fraction. It is important not to over pulverize the sample too finely; as tests have shown gold will plate out on the mill and be lost. When assays have been completed on the coarse and fine portions of the bulk sample, a final assay is calculated based on the weight of each fraction.

When submitting samples for precious metals analysis, please provide at least 2-3 times the listed sample weight to allow for quality control analysis



Gold, Platinum, Palladium and Rhodium

Code	Method	Sample Weight (g)	Range (ppb)				Price
			Au	Pt	Pd	Rh	
1C-Exploration	Fire Assay - ICP-MS	30	2 - 30,000	1 - 30,000	1 - 30,000	-	$23.40
1C-Research	Fire Assay - ICP-MS	30	1 - 30,000	0.1 - 30,000	0.1 - 30,000	-	$32.65
1C-Rhodium	Fire Assay - ICP-MS	30	-	-	-	5 - 10,000	$31.50
1C-OES	Fire Assay - ICP-OES	30	2 - 30,000	5 - 30,000	5 - 30,000	-	$20.70
1C-OES-ORE *	Fire Assay - ICP-OES	30	0.006 - 1000 g/T	0.001 - 1000 g/T	0.001 - 1000 g/T	-	$40.50

* If above 1000g/T, see Concentrate Testing

Platinum Group Elements

Code	Method	Sample Weight (g)	Range (ppb)							Price
			Os	Ir	Ru	Rh	Pt	Pd	Au	
1B1	NiS Fire Assay - INAA	30	2-20,000	0.1-10,000	5-50,000	0.2-20,000	5*-100,000	2-100,000	0.5-20,000	1-2 samples $343.05 3+ samples $172.00
1B2	NiS Fire Assay - ICP-MS	30	-	1-10,000	1-10,000	1-10,000	1-10,000	1-10,000	1-10,000	1-2 samples $343.05 3+ samples $172.00

* Detection limits for Pt are increased with high Au/Pt ratios and limits for other elements will be affected by abnormally high Au, Sb and Cu content. Samples with high Au can be reanalyzed by Code 1C exploration or research. Zn concentrates are not amenable to the nickel sulphide fire assay. Au results by Code 1B1 or 1B2 can be low by nickel sulphide fire assay. For accurate Au values, please request Code 1C-exploration.

Aqua Regia "Partial" Digestion

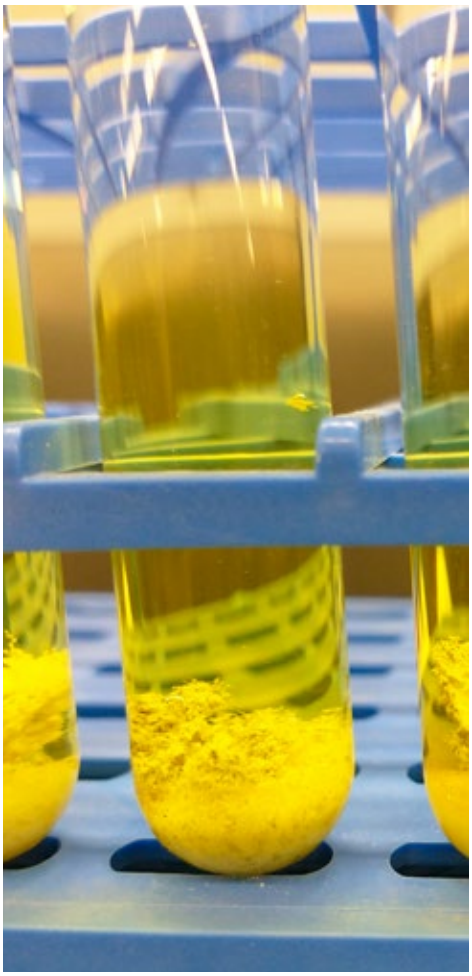
This digestion uses a combination of concentrated hydrochloric and nitric acids to leach sulphides, some oxides and some silicates. Mineral phases which are hardly (if at all) attacked include barite, zircon, monazite, sphene, chromite, gahnite, garnet, ilmenite, rutile and cassiterite. The balance of silicates and oxides are only slightly to moderately attacked, depending on the degree of alteration. Generally, but not always, most base metals and gold are usually dissolved.

Note: Results from acid digestions may be lab dependent or lab operator dependent. Actlabs has automated this aspect of digestion using a microprocessor designed hotbox to accurately reproduce digestion conditions every time.

Note: For Code Ultratrace 1, Code Ultratrace 2 and Code UT-1M, Au is semi-quantitative when using a 0.5g sample.

15g or 30g is recommend for soils, sediments and vegetation samples only.

Packages that involve 15g and 30g sample size will require RX10 (pulp weight report)



	ICP-OES (ppm)		ICP-MS (ppm)		ICP-OES + ICP-MS (ppm)
Package	**1E**	**1E3**	**UT-1M**	**Ultratrace 1**	**Ultratrace 2**
Ag	0.2 - 100	0.2 - 100	0.1 - 100	0.002 - 100	0.002 - 100
Al	-	0.01 - 10 %	0.01 - 8 %	0.01 - 8 %	0.01 - 8 %
As	-	2 - 10,000	0.5 - 10,000	0.1 - 10,000	0.1 - 10,000
Au	-	-	0.5 - 1,000 ppb	0.5 - 10,000 ppb	0.5 - 10,000 ppb
B	-	10 - 10,000	20 - 2,000	1 - 5,000	1 - 5,000
Ba	-	10 - 10,000	1 - 10,000	0.5 - 6,000	0.5 - 6,000
Be	-	0.5 - 1,000	-	0.1 - 1,000	0.1 - 1,000
Bi	-	2 - 10,000	0.1 - 2,000	0.02 - 2,000	0.02 - 2,000
Ca	-	0.01 - 10 %	0.01 - 50 %	0.01 - 50 %	0.01 - 50 %
Cd	0.5 - 2,000	0.5 - 2,000	0.1 - 2,000	0.01 - 2,000	0.01 - 1,000
Ce	-	-	-	0.01 - 10,000	0.01 - 10,000
Co	-	1 - 10,000	0.1 - 5,000	0.1 - 5,000	0.1 - 5,000
Cr	-	1 - 10,000	1 - 10,000	1 - 10,000	1 - 10,000
Cs	-	-	-	0.02 - 500	0.02 - 500
Cu	1 - 10,000	1 - 10,000	0.2 - 10,000	0.2 - 10,000	0.2 - 10,000
Dy	-	-	-	0.1 - 1,000	0.1 - 1,000
Er	-	-	-	0.1 - 1,000	0.1
Eu	-	-	-	0.1 - 100	0.1
Fe	-	0.01 - 30 %	0.01 - 30 %	0.01 - 30 %	0.01 - 30 %
Ga	-	10 - 10,000	1 - 1,000	0.02 - 500	0.02 - 500
Gd	-	-	-	0.1 - 1,000	0.1 - 1,000
Ge	-	-	-	0.1 - 500	0.1 - 500
Hf	-	-	-	0.1 - 500	0.1 - 500
Hg	1 - 10,000	1 - 10,000	0.01 - 50	10 - 10,000ppb	10 - 10,000 ppb
Ho	-	-	-	0.1 - 1,000	0.1 - 1,000
In	-	-	-	0.02 - 500	0.02 - 500
K	-	0.01 - 10 %	0.01 - 5 %	0.01 - 5 %	0.01 - 5 %
La	-	10 - 10,000	1 - 10,000	0.5 - 10,000	0.5 - 1,000
Li	-	-	-	0.1 - 10,000	0.1 - 10,000
Lu	-	-	-	0.1 - 100	0.1 - 100
Mg	-	0.01 - 25 %	0.01 - 10 %	0.01 - 10 %	0.01 - 10 %
Mn	2 - 100,000	5 - 100,000	1 - 10,000	1 - 10,000	1 - 10,000
Mo	2 - 10,000	1 - 10,000	0.1 - 10,000	0.01 - 10,000	0.01 - 10,000
Na	-	0.001 - 10 %	0.001 - 5 %	0.001 - 5 %	0.001 - 5 %
Nb	-	-	-	0.1 - 500	0.1 - 500
Nd	-	-	-	0.02 -5,000	0.02 - 5,000
Ni	1 - 10,000	1 - 10,000	0.1 - 10,000	0.1 - 10,000	0.1 - 10,000
P	-	0.001 - 5 %	0.001 - 5 %	0.001 - 5 %	0.001 - 5 %
Pb	2 - 5,000	2 - 5,000	0.1 - 5,000	0.1 - 5,000	0.1 - 5,000
Pr	-	-	-	0.1 -1,000	0.1 - 1,000
Rb	-	-	-	0.1 - 500	0.1 - 500
Re	-	-	-	0.001 - 100	0.001 - 100
S +	0.001 - 20 %	0.001 - 20 %	1 - 20 %	1 - 20 %	0.001 - 20 %
Sb	-	2 - 10,000	0.1 - 500	0.02 - 500	0.02 - 500
Sc	-	1 - 10,000	0.1 - 10,000	0.1 - 10,000	0.1 - 10,000
Se	-	-	0.5 - 10,000	0.1 - 10,000	0.1 - 10,000
Sm	-	-	-	0.1 - 100	0.1 - 100
Sn	-	-	-	0.05 - 200	0.05 - 200
Sr	-	1 - 10,000	1 - 5,000	0.5 - 5,000	0.5 - 5,000
Ta	-	-	-	0.05 - 50	0.05 - 50
Tb	-	-	-	0.1 - 100	0.1 - 100
Te	-	1 - 500	0.2 - 500	0.02 - 500	0.02 - 500
Th	-	20 - 10,000	0.1 - 200	0.1 - 200	0.1 - 200
Ti	-	0.01 - 10 %	0.001 - 10 %	0.001 - 10 %	0.01 - 10 %
Tl	-	2 - 10,000	0.1 - 500	0.02 - 500	0.02 - 500
Tm	-	-	-	0.1 - 1,000	0.1 - 1,000
U	-	10 - 10,000	-	0.1 - 10,000	0.1 - 10,000
V	-	1 - 10,000	2 - 1,000	1 - 1,000	1 - 1,000
W	-	10 - 200	0.1 - 200	0.1 - 200	0.1 - 200
Y	-	1 - 1,000	-	0.01 - 500	0.01 - 500
Yb	-	-	-	0.1 - 200	0.1 - 200
Zn	1 - 10,000	2 - 10,000	1 - 5,000	0.1 - 5,000	0.1 - 5,000
Zr	-	1 - 10,000	-	0.1- 5,000	0.1 - 5,000
0.5g Price:	$12.15	$12.85	$18.00	$22.95	$25.90
		15g Price	$27.00	$30.15	
		30g Price	$30.30	$33.10	

Extraction of each element by Aqua Regia is dependent on mineralogy
+ Sulphide sulphur and soluble sulphates are extracted

4-Acid "Near Total" Digestion

This acid attack is the most vigorous digestion used in geochemistry analysis and uses hydrochloric, nitric, perchloric and hydrofluoric acids. Even with this digestion, certain minerals (barite, gahnite, chromite, cassiterite, etc.) may only be partially dissolved or stable in solution. Other minerals including zircon, sphene and magnetite may not be totally dissolved. Most other silicates will be dissolved; however, some elements will be erratically volatilized, including As, Sb, Cr, U and Au.

Near-Total digestion cannot be used to obtain accurate determinations of REE, Ta, Nb, As, Sb, Sn, Hg, Cr, Au and U.

	ICP-OES (ppm)	ICP-MS (ppm)		ICP-OES + ICP-MS (ppm)	
Package	1F2	UT-4M	Ultratrace 4	Ultratrace 6	UT-6M
Ag	0.3 - 100	0.1 - 100	0.05 - 100	0.3 – 100	0.01 - 100
Al	0.01 - 50 %	0.01 - 20 %	0.01 - 10 %	0.01 - 10 %	0.01 - 50 %
As	3 - 5,000	1 - 10,000	0.1 - 10,000	0.1 - 10,000	0.2 - 10,000
B	-	-	20 - 6,000	-	-
Ba	7 - 1,000	1 - 10,000	1 - 5,000	1 - 5,000	10 - 10,000
Be	1 - 10,000	1 - 1,000	0.1 - 1,000	0.1 - 1,000	0.05 - 1,000
Bi	2 - 10,000	0.1 - 4,000	0.02 - 2,000	0.02 - 2,000	0.01 - 10,000
Ca	0.01 - 70 %	0.01 - 40 %	0.01 - 50 %	0.01 - 50 %	0.01 - 50 %
Cd	0.3 - 2,000	0.1 - 4,000	0.1 - 1,000	0.3 – 2,000	0.02 - 1,000
Ce	-	1 - 2,000	0.1 - 10,000	0.1 - 10,000	0.01 - 500
Co	1 - 10,000	0.2 - 4,000	0.1 - 500	1 – 10,000	0.1 - 10,000
Cr	1 - 10,000	1 - 10,000	1 - 5,000	1 - 5,000	1 - 10,000
Cs	-	0.1 - 10,000	0.05 - 100	0.05 - 100	0.05 - 500
Cu	1 - 10,000	0.1 - 10,000	0.2 - 10,000	1 – 10,000	0.2 - 10,000
Dy	-	-	0.1 - 5000	0.1 - 5,000	-
Er	-	-	0.1 - 1,000	0.1 - 1,000	-
Eu	-	-	0.05 - 100	0.05 - 100	-
Fe	0.01 - 50 %	0.01 - 60 %	0.01 - 50 %	0.01 - 50 %	0.01 - 50 %
Ga	1 - 10,000	-	0.1 - 500	0.1 - 500	0.05 - 10,000
Gd	-	-	0.1 - 5,000	0.1 - 5,000	-
Ge	-	-	0.1 - 500	0.1 - 500	0.05 - 500
Hf	-	0.1 - 1,000	0.1 - 500	0.1 - 500	0.1 - 500
Ho	-	-	0.1 - 1,000	0.1 - 1,000	-
In	-	-	0.1 - 100	0.1 - 100	0.005 - 500
K	0.01 - 10 %	0.01 - 10 %	0.01 - 5 %	0.01 - 5 %	0.01 - 10 %
La	-	0.1 - 2,000	0.1 - 10,000	0.1 - 10,000	0.5 - 10,000
Li	1 - 10,000	0.1 - 2,000	0.5 - 400	1 – 10,000	0.2 - 10,000
Lu	-	-	0.1 - 100	0.1 - 100	-
Mg	0.01 - 50 %	0.01 - 30 %	0.01 - 50 %	0.01 - 50 %	0.01 - 50 %
Mn	1 - 100,000	1 - 10,000	1 - 10,000	1 - 10,000	5 - 100,000
Mo	1 - 10,000	0.1 - 4,000	0.05 - 10,000	1 – 10,000	0.05 - 10,000
Na	0.01 - 10 %	0.001 - 10 %	0.01 - 3 %	0.01 - 3 %	0.01 - 10 %
Nb	-	0.1 - 2,000	0.1 - 500	0.1 - 500	0.1 - 500
Nd	-	-	0.1 - 10,000	0.1 - 10,000	-
Ni	1 - 10,000	0.1 - 10,000	0.5 - 5,000	1 – 10,000	0.2 - 10,000
P	0.001 - 10 %	0.001 - 5 %	-	0.001 - 10 %	10 - 10,000
Pb	3 - 5,000	0.1 - 5,000	0.5 - 5,000	3 – 5,000	0.5 - 10,000
Pr	-	-	0.1 - 5,000	0.1 - 1,000	-
Rb	-	0.1 - 2,000	0.2 - 500	0.2 - 5,000	0.1 - 10,000
Re	-	-	0.001 - 100	0.001 - 100	0.002 - 50
S +	0.01 - 20 %	1 - 10 %	-	0.01 - 20 %	0.01 - 10 %
Sb	5 - 10,000	0.1 - 4,000	0.1 - 500	0.1 - 500	0.05 - 10,000
Sc	4 - 10,000	1 - 200	-	1 - 5,000	0.1 - 10,000
Se	-	-	0.1 - 1,000	0.1 - 1,000	1 - 1,000
Sm	-	-	0.1 - 100	0.1 - 100	-
Sn	-	0.1 - 2,000	1 - 200	1- 200	0.2 - 500
Sr	1 - 10,000	1 - 10,000	0.2 - 10,000	0.2 - 1,000	0.2 - 10,000
Ta	-	0.1 - 2,000	0.1 - 1,000	0.1 - 1,000	0.05 - 100
Tb	-	-	0.1 - 100	0.1 - 100	-
Te	2 -10,000	-	0.1 - 500	0.1 - 500	0.05 - 500
Th	-	0.1 - 4,000	0.1 - 500	0.1 - 500	0.01 - 10,000
Ti	0.01 - 10 %	0.001 - 10 %	-	0.0005 - 10 %	0.005 - 10 %
Tl	5 - 10,000	0.05 - 10,000	0.05 - 500	0.05 - 500	0.02 - 10,000
Tm	-	-	0.1 -1,000	0.1 - 1,000	-
U	10 - 10,000	0.1 - 4,000	0.1 - 10,000	0.1 - 10,000	0.1 - 10,000
V	2 - 10,000	4 - 10,000	1 - 10,000	1 - 10,000	1 - 10,000
W	5 - 10,000	0.1 - 200	0.1 - 200	0.1 - 200	0.1 - 10,000
Y	1 - 1,000	0.1 - 2,000	0.1 - 10,000	0.1 - 10,000	0.1 - 500
Yb	-	-	0.1 - 5,000	0.1 - 5,000	-
Zn	1 - 10,000	1 - 10,000	0.2 - 10,000	1 – 10,000	2 - 10,000
Zr	5 - 10,000	0.1 - 2,000	1 - 5,000	1 - 5,000	0.5 - 500
Price:	$17.10	$23.20	$26.10	$32.85	$29.25

Extraction of each element by 4-Acid Digestion is dependent on mineralogy
+ Sulphide sulphur and soluble sulphates are extracted

Intermediate Ore Grade

These packages are meant for mid-high level mineralized samples.

	Aqua Regia (ppm)		Four-Acid (ppm)		
Package	**1E3-ORE**	**UT1-ORE**	**1F2-ORE**	**UT4-ORE**	**UT6-ORE**
Ag	2 - 100	1 - 100	3 - 100	0.5 - 100	3 – 100
Al	0.1 - 10 %	0.1 - 8 %	0.1 - 50 %	0.1 - 10 %	0.1 - 10 %
As	20 - 10,000	5 - 10,000	30 - 5,000	1 - 10,000	1 - 10,000
Au	-	5 - 1,000 ppb	-	-	-
B	100 - 10,000	200 - 2,000	-	200 - 6,000	-
Ba	100 - 10,000	10 - 10,000	70 - 1,000	10 - 5,000	10 - 5,000
Be	5 - 1,000	-	10 - 10,000	1 - 1,000	1 - 1,000
Bi	20 - 10,000	1 - 2,000	20 - 10,000	0.2 - 2,000	0.2 - 2,000
Ca	0.1 - 10 %	0.1 - 25 %	0.1 - 70 %	0.1 - 50 %	0.1 - 50 %
Cd	5 - 2,000	1 - 2,000	3 - 2,000	1 - 1,000	3 – 2,000
Ce	-	-	-	1 - 10,000	1 - 10,000
Co	10 - 10,000	1 - 5,000	10 - 10,000	1 - 500	10 – 10,000
Cr	10 - 10,000	10 - 10,000	10 - 10,000	10 - 5,000	10 - 5,000
Cs	-	-	-	0.5 - 100	0.5 - 100
Cu	10 - 10,000	2 - 10,000	10 - 10,000	2 - 10,000	10 – 10,000
Dy	-	-	-	1 - 5000	1 - 5,000
Er	-	-	-	1 - 1,000	1 - 1,000
Eu	-	-	-	0.5 - 100	0.5 - 100
Fe	0.1 - 30 %	0.1 - 30 %	0.1 - 50 %	0.1 - 50 %	0.1 - 50 %
Ga	100 - 10,000	10 - 1,000	10 - 10,000	1 - 500	1 - 500
Gd	-	-	-	1 - 5,000	1 - 5,000
Ge	-	-	-	1 - 500	1 - 500
Hf	-	-	-	1 - 500	1 - 500
Hg	10 - 10,000	0.1 - 50	-	-	-
Ho	-	-	-	1 - 1,000	1 - 1,000
In	-	-	-	1 - 100	1 - 100
K	0.01 - 10 %	0.1 - 5 %	0.1 - 10 %	0.1 - 5 %	0.1 - 5 %
La	100- 10,000	10 - 10,000	-	1 - 10,000	1 - 10,000
Li	-	-	1 0- 10,000	5 - 400	10 – 10,000
Lu	-	-	-	1 - 100	1 - 100
Mg	0.1 - 25 %	0.1 - 10 %	0.1 - 50 %	0.1 - 50 %	0.1 - 50 %
Mn	50 - 100,000	10 - 10,000	1 0- 100,000	10 - 10,000	10 - 10,000
Mo	10 - 10,000	1 - 10,000	1 0- 10,000	0.5 - 10,000	10 – 10,000
Na	0.01 - 10 %	0.01 - 5 %	0.1 - 10 %	0.1 - 3 %	0.1 - 3 %
Nb	-	-	-	1 - 500	1 - 500
Nd	-	-	-	1 - 10,000	1 - 10,000
Ni	10 - 10,000	1 - 10,000	1 0- 10,000	5 - 5,000	10 – 10,000
P	0.01 - 5 %	0.01 - 5 %	0.01 - 10 %	-	0.01 - 10 %
Pb	20 - 5,000	1 - 5,000	30 - 5,000	5 - 5,000	30 – 5,000
Pr	-	-	-	1 - 5,000	1 - 1,000
Rb	-	-	-	2 - 500	2 - 5,000
Re	-	-	-	0.01 - 100	0.01 - 100
S +	0.1 - 20 %	10 - 20 %	0.1 - 20 %	-	0.1 - 20 %
Sb	20 - 10,000	1 - 500	50- 10,000	1 - 500	1 - 500
Sc	10 - 10,000	1 - 10,000	40 - 10,000	-	10 - 5,000
Se	-	5 - 10,000	-	1 - 1,000	1 - 1,000
Sm	-	-	-	1 - 100	1 - 100
Sn	-	-	-	10 - 200	10- 200
Sr	10 - 10,000	10- 5,000	10 - 10,000	2 - 10,000	2 - 1,000
Ta	-	-	-	1 - 1,000	1 - 1,000
Tb	-	-	-	1 - 100	1 - 100
Te	10 - 500	2 - 500	20 -10,000	1 - 500	1 - 500
Th	200 - 10,000	1 - 200	-	1 - 500	1 - 500
Ti	0.1 - 10 %	0.01 - 10 %	0.1 - 10 %	-	0.005 - 10 %
Tl	20 - 10,000	1 - 500	50 - 10,000	0.5 - 500	0.5 - 500
Tm	-	-	-	1 -1,000	1 - 1,000
U	100 - 10,000	-	100 - 10,000	1 - 10,000	1 - 10,000
V	10 - 10,000	20 - 1,000	20 - 10,000	10 - 10,000	10 - 10,000
W	100 - 200	1 - 200	50 - 10,000	1 - 200	1 - 200
Y	10 - 1,000	-	1 0- 1,000	1 - 10,000	1 - 10,000
Yb	-	-	-	1 - 5,000	1 - 5,000
Zn	20 - 10,000	10 - 5,000	1 0- 10,000	2 - 10,000	10 – 10,000
Zr	10 - 10,000	-	50 - 10,000	10 - 5,000	10 - 5,000
Price:	$14.20	$22.70	$19.40	$27.00	$36.40

Extraction of each element by 4-Acid Digestion is dependent on mineralogy
+ Sulphide sulphur and soluble sulphates are extracted

INAA

Instrumental Neutron Activation Analysis - Samples are encapsulated and irradiated in a nuclear reactor. After a suitable decay, samples are measured for the emitted gamma ray fingerprint. INAA is very good for Au, Co, As, Sb, W, Ta, U, Th, Cs, In, Re, Cl and lower levels of most LREE.

	INAA (ppm)			
Package	1D	1D Enhanced	5B - Other Elements	5S - Short Lived Isotopes
Ag	5 - 100,000	5 - 100,000	-	
Al	-	-	-	1 - 100,000
As	2 - 10,000	0.5 - 10,000	1 - 10,000	-
Au	5 - 30,000 ppb	2 - 30,000 ppb	5 - 30,000 ppb	-
Ba	100 - 500,000	50 - 500,000	100 - 100,000	-
Br	1 - 1,000	0.5 - 1,000	0.5 - 1,000	5 - 10,000
Ca	1 - 50 %	1 - 50 %	-	-
Ce	3 - 10,000	3 - 10,000	3 - 10,000	-
Co	5 - 5,000	1 - 5,000	0.5 - 10,000	-
Cl	-	-	-	100 -100,000
Cr	10 - 100,000	5 - 100,000	1 - 100,000	-
Cs	2 - 10,000	1 - 10,000	0.5 - 10,000	-
Cu	-	-	-	5 - 2,500
Dy	-	-	-	0.5 - 5,000
Eu	0.2 - 2,000	0.2 - 2,000	0.2 - 2,000	-
Fe	0.02 - 75 %	0.01 - 75 %	0.01 - 75 %	-
Ga	-	-	-	5 - 10,000
Hf	1 - 500	1 - 500	0.5 - 500	-
Hg	1 - 1,000	1 - 1,000	-	-
I	-	-	-	0.5 - 5,000
In	-	-	-	0.1 - 5,000
Ir	5 - 10,000 ppb	5 - 10,000 ppb	-	-
La	1 - 10,000	0.5 - 10,000	0.1 - 10,000	-
Lu	0.05 - 1,000	0.05 - 1,000	0.05 - 1,000	-
Mg	-	-	-	0.05 - 50 %
Mn	-	-	-	0.1 - 10,000
Mo	5 - 10,000	1 - 10,000	2 - 10,000	-
Na	0.05 - 10 %	0.01 - 10 %	100 - 100,000	50 - 200,000
Nd	5 - 10,000	5 - 10,000	5 - 10,000	-
Ni	50 - 10,000	20 - 10,000	-	-
Rb	30 - 10,000	15 - 10,000	20 - 10,000	-
Re	-	-	-	1 - 5,000
Sb	0.2 - 10,000	0.1 - 10,000	0.1 - 10,000	-
Sc	0.1 - 200	0.1 - 200	0.1 - 200	-
Se	5 - 10,000	3 - 10,000	2 - 10,000	-
Sm	0.1 - 10,000	0.1 - 10,000	0.01 - 10,000	-
Sn	0.05 - 10 %	0.02 - 10 %	-	-
Sr	0.1 - 40 %	0.05 - 40 %	-	-
Ta	1 - 10,000	0.5 - 10,000	0.5 - 10,000	-
Tb	0.5 - 1,000	0.5 - 1,000	-	-
Th	0.5-10,000	0.5-10,000	0.2-10,000	-
Ti	-	-	-	50 - 100,000
U	0.5 - 10,000	0.5 - 10,000	0.1 - 10,000	-
V	-	-	-	0.1 - 10,000
W	4 - 10,000	1 - 10,000	2 - 10,000	-
Yb	0.2 - 1,000	0.2 - 1,000	0.2 - 1,000	-
Zn	50 - 100,000	50 - 100,000	-	-
Price:	$24.75	$28.00	One Element $21.60	One Element $45.05
		Each Additional Element	add $3.05	add $7.55

Key advantages of INAA include:

- **Total determination of selected resistive and volatile elements, including Au**
- **Up to 30g of material can be analyzed for a more representative sub-sample**
- **Non-destructive, allowing material to be used for other analysis**

Multi-Method Analyses

ICP-OES and ICP-MS analyses by 4-acid (hydrochloric, nitric, perchloric and hydrofluoric) digestion are “near total” digestions. INAA analysis yields total metals.

NOTE: Results from acid digestions may be lab dependent or lab operator dependent. Actlabs has automated this aspect of digestion using a microprocessor designed hotbox to accurately reproduce digestion conditions every time.

Pressed Pellet XRF Analysis

Code 4C1		
Group	**Element**	**Range (ppm)**
A	Ba	5-10,000
	Ga	5-10,000
	Nb	1-10,000
	Rb	2-10,000
	Sr	2-10,000
	Y	2-10,000
	Zr	5-10,000
B	Co	5-1,000
	Cr	5-10,000
	Cu	5-2,500
	Ni	4-4,000
	Pb	5-1,000
	V	5-10,000
	Zn	5-1,000
	Sn	5-10,000
	Zn	0.001-1%

Any One Element	$11.25
Each Additional Element	$3.85
All of Group A Elements	$20.70
All of Group B Elements	$20.70

	INAA+ICP-OES (ppm)	INAA + ICP-OES + ICP-MS (ppm)	INAA+ICP-MS (ppm)
Package	**1H**	**Ultratrace 3**	**Ultratrace 5**
Ag	0.3 - 10,000	0.05 - 10,000	0.05 - 100,000
Al	0.01 -50 %	0.01 - 50 %	-
As	0.5 - 10,000	0.5 - 10,000	0.5 - 10,000
Au	2 - 30,000 ppb	2 - 30,000 ppb	2 - 30,000 ppb
Ba	50 - 500,000	1 - 100,000	1 - 100,000
Be	1 - 10,000	0.1 - 1,000	0.1 - 1,000
Bi	2 -10,000	0.02 - 10,000	0.02 - 2,000
Br	0.5 -5,000	0.5 - 5,000	0.5 - 5,000
Ca	0.01 - 70 %	0.01 - 70 %	0.01 - 50 %
Cd	0.3 - 2,000	0.1 - 2,000	0.1 - 1,000
Ce	3 - 10,000	0.1 - 10,000	0.1 - 10,000
Co	1 - 5,000	1 - 5,000	0.1 - 5,000
Cr	2 - 100,000	1 - 10,000	1 - 100,000
Cs	1 - 10,000	0.05 - 5,000	0.05 - 5,000
Cu	1 - 10,000	0.2 - 10,000	0.2 - 10,000
Dy	-	0.1 - 5000	0.1 - 5000
Er	-	0.1 - 1,000	0.1 - 1,000
Eu	0.2 - 10,000	0.05 - 1,000	0.05 - 100
Fe	0.01 - 70 %	0.01 - 70 %	0.01 - 50 %
Ga	-	0.1 - 500	0.1 - 500
Gd	-	0.1 - 500	0.1 - 5,000
Ge	-	0.1 - 500	0.1 - 500
Hf	1 -5,000	0.1 - 5,000	1 - 5,000
Hg	1 - 1,000	1 - 1,000	1 - 1,000
Ho	-	0.1 - 1,000	0.1 - 1,000
In	-	0.1 - 100	0.1 - 100
Ir	5 - 10,000 ppb	5 - 10,000 ppb	-
K	0.01 - 10 %	0.01 - 10 %	0.01 - 5 %
La	0.5 - 10,000	0.5 - 10,000	0.1 - 10,000
Li	1 - 10,000	1 - 10,000	0.5 - 400
Lu	0.05 - 10,000	0.1 - 100	0.1 - 100
Mg	0.01 - 50 %	0.01 - 50 %	0.01 - 10 %
Mn	1 - 100,000	1 - 100,000	1 - 10,000
Mo	1 - 10,000	0.2 - 10,000	0.05 - 10,000
Na	0.01 - 50 %	0.01 - 20 %	0.01 - 20 %
Nb	-	0.1 - 500	0.1 - 500
Nd	5 - 10,000	0.01 - 10,000	0.1 - 10,000
Ni	1 - 100,000	0.5 - 100,000	0.5 - 100,000
P	0.001 - 10 %	0.001 - 10 %	-
Pb	3 - 5,000	0.5 - 5,000	0.5 - 5,000
Pr	-	0.1 - 1,000	0.1 - 1,000
Rb	15 -10,000	0.2 - 5,000	0.2 - 5,000
Re	-	0.001 - 100	0.001 - 100
S +	0.01 - 20 %	0.01 - 20 %	-
Sb	0.1 - 10,000	0.1 - 10,000	0.1 - 10,000
Sc	0.1 - 1,000	0.1 - 1,000	0.1 - 1,000
Se	3 - 10,000	0.1 - 10,000	0.1 - 10,000
Sm	0.1 - 10,000	0.1 - 100	0.1 - 100
Sn	0.02 - 20 %	1 - 200	1- 200
Sr	1 - 10,000	0.2 - 1,000	0.2 - 1,000
Ta	0.5 - 10,000	0.1 - 10,000	0.1 - 10,000
Tb	0.5 - 10,000	0.1 - 5,000	0.1 - 100
Te	-	0.02 - 500	0.1 - 500
Th	0.2 - 10,000	0.1 - 10,000	0.1 - 10,000
Ti	0.01 - 10 %	0.01 - 10 %	-
Tl	-	0.05 - 500	0.05 - 500
Tm	-	0.1 - 1,000	0.1 - 1,000
U	0.5 - 10,000	0.1 - 10,000	0.1 - 10,000
V	2 - 10,000	2 - 10,000	1 - 1,000
W	1 - 10,000	1 - 10,000	1 - 10,000
Y	1 - 1,000	0.01 - 10,000	0.1 - 10,000
Yb	0.2 - 10,000	0.1 - 5,000	0.1 - 5,000
Zn	1 - 100,000	0.5 - 100,000	0.5 - 100,000
Zr	-	1 - 5,000	1 - 5,000
Price:	$37.15	$50.40	$38.00

Extraction of each element by 4-Acid Digestion is dependent on mineralogy
+ Sulphide sulphur and soluble sulphates are extracted

Lithogeochemistry and Whole Rock Analysis

Lithogeochemistry

The most aggressive fusion technique employs a lithium metaborate/ tetraborate fusion. Fusion is performed by a robot at Actlabs, which provides a fast fusion of the highest quality in the industry. The resulting molten bead is rapidly digested in a weak nitric acid solution. The fusion ensures that the entire sample is dissolved. It is only with this attack that major oxides including SiO2, refractory minerals (i.e. zircon, sphene, monazite, chromite, gahnite, etc.), REE and other high field strength elements are put into solution. High sulphide-bearing rocks may require different treatment but can still be adequately analyzed. Analysis is by ICP-OES and ICP-MS. Quality of data is exceptional and can be used for the most exacting applications. Values on internal replicates and standards are provided at no cost, as are REE chondrite plots. Eu determinations are semiquantitative in samples having extremely high Ba concentrations (> 5 %).

Mineralized Samples: Although intended primarily for unmineralized samples, mineralized samples can be analyzed. However, data may be semiquantitative for chalcophile elements (Ag, As, Bi, Co, Cu, Mo, Ni, Pb, Sb, Sn, W and Zn). For quantitative chalcophile data see Quant add-ons below.

Code 4B: Lithium Borate Fusion / ICP-OES Whole Rock Package. Data meets or exceeds quality of data by fusion XRF. 3g required.

Code 4B2: Lithium Borate Fusion / ICP-MS Trace Element package: Codes 4B2-STD and 4B2-Research both provide research quality data. 0.5g required.

Research designation: indicates lower detection limits.

Code 4Litho and Code 4Lithoresearch: The 4B and 4B2 packages are combined. 5 g required.

Quant designation: For quantitative values of chalcophile elements a surcharge will apply. A minimum sample weight of 5 g is required.

(+) Code 4B1: Optional elements by multiacid digestion. Please add 0.5 g.

(++) Code 4B-INAA: Optional elements are available by INAA. Please add 0.5 to 30 g depending on sample size you prefer to analyze for Au with this option.

Add-ons	Surcharge
4B1	$11.70
4B-INAA	$20.70
QUANT	$19.80

	WRA-ICP	Trace Element	Trace Element	WRA+ICP	WRA+Trace
Package	4B	4B2-Std	4B2-Research	4 Litho	4 Lithoresearch
Al_2O_3	0.01%	-	-	0.01%	0.01%
CaO	0.01%	-	-	0.01%	0.01%
Fe_2O_3	0.01%	-	-	0.01%	0.01%
K_20	0.01%	-	-	0.01%	0.01%
MgO	0.01%	-	-	0.01%	0.01%
MnO	0.005%	-	-	0.005%	0.005%
Na_2O	0.01%	-	-	0.01%	0.01%
P_2O_5	0.01%	-	-	0.01%	0.01%
SiO_2	0.01%	-	-	0.01%	0.01%
TiO_2	0.001%	-	-	0.001%	0.001%
LOI	0.01%	-	-	0.01%	0.01%
Ag	(0.3+)	0.5	0.5	0.5	0.5
As	(0.5++)	5 (0.5++)	5 (0.5++)	5 (0.5++)	5 (0.5++)
Au	(2ppb++)	(2ppb++)	(2ppb++)	(2ppb++)	(2ppb++)
Ba	2	3	3	2	2
Be	1			1	1
Bi		0.4	0.1	0.4	0.1
Br	(0.5++)	(0.5++)	(0.5++)	(0.5++)	(0.5++)
Cd	(0.5+)	(0.5+)	(0.5+)	(0.5+)	(0.5+)
Co	(1++)	1	1	1	1
Cr	(0.5++)	20 (0.5++)	20 (0.5++)	20 (0.5++)	20 (0.5++)
Cs	(1++)	0.5	0.1	0.5	0.1
Cu	(1+)	10 (1+)	10 (1+)	10 (1+)	10 (1+)
Fe		(0.01%++)	(0.01%++)		
Ga		1	1	1	1
Ge		1	0.5	1	0.5
Hf	(1++)	0.2	0.1	0.2	0.1
In		0.2	0.1	0.2	0.1
Ir	(5ppb++)	(5ppb++)	(5ppb++)	(5ppb++)	(5ppb++)
Mo	(5++)	2	2	2	2
Na		(0.01%++)	(0.01%++)		
Nb		1	0.2	1	0.2
Ni	(1+)	20 (1+)	20 (1+)	20 (1+)	20 (1+)
Pb	(5+)	5	5	5	5
Rb	(20++)	2	1	2	1
S	(10+)	(10+)	(10+)	(10+)	(10+)
Sb	(0.2++)	0.5 (0.2++)	0.2	0.5 (0.2++)	0.2
Sc	1	(0.1++)	(0.1++)	1 (0.1++)	1 (0.1++)
Se	(3++)	(3++)	(3++)	(3++)	(3++)
Sn		1	1	1	1
Sr	2	2	2	2	2
Ta	(0.5++)	0.1	0.01	0.1	0.01
Th	(0.2++)	0.1	0.05	0.1	0.05
Tl		0.1	0.05	0.1	0.05
U	(0.5++)	0.1	0.01	0.1	0.01
V	5	5	5	5	5
W	(1++)	1	0.5	1	0.5
Y	1	1	0.5	1	0.5
Zn	(1+)	30 (1+)	30 (1+)	30 (1+)	30 (1+)
Zr	2	5	1	2	1
La	(0.5++)	0.1	0.05	0.1	0.05
Ce	(3++)	0.1	0.05	0.1	0.05
Pr		0.05	0.01	0.05	0.01
Nd	(5++)	0.1	0.05	0.1	0.05
Sm	(0.1++)	0.1	0.01	0.1	0.01
Eu	(0.2++)	0.05	0.005	0.05	0.005
Gd		0.1	0.01	0.1	0.01
Tb	(0.5++)	0.1	0.01	0.1	0.01
Dy		0.1	0.01	0.1	0.01
Ho		0.1	0.01	0.1	0.01
Er		0.1	0.01	0.1	0.01
Tm		0.05	0.005	0.05	0.005
Yb	(0.2++)	0.01	0.002	0.01	0.002
Lu	(0.005++)	0.01	0.002	0.01	0.002
1-10 Samples	$35.10	$56.70	$94.50	$81.00	$117.00
11+ Samples	$30.60	$52.20	$77.40	$67.50	$94.50

All elements are in ppm except where noted. Prices per sample.
+ Sulphide sulphur and soluble sulphates are extracted

Lithogeochemistry and Whole Rock Analysis

Code 4C: Lithium Borate Fusion / XRF Whole Rock Package. Samples containing >1% barite or sulphide should be analyzed with Code 4B. A minimum sample weight of 3g is required. We reserve the right to change analytical method to Code 4B if required by the sample composition.

WRA-XRF	
Package	4C
Al_2O_3	0.01%
CaO	0.01%
Cr_2O_3	0.01%
Co_3O_4	0.005%
CuO	0.005%
Fe_2O_3	0.01%
K_20	0.01%
MgO	0.01%
MnO	0.005%
Na_2O	0.01%
NiO	0.003%
P_2O_5	0.01%
SiO_2	0.01%
TiO_2	0.01%
V_2O_5	0.003%
LOI	0.01%
1-10 Samples	$33.30
11+ Samples	$29.70

When submitting pulp material it must be 95% -74 µm or additional pulverization charges will apply.

Add-ons	Surcharge
4E-XRF	$22.70
4E ICP-MS	$37.35

INAA and multi-methods			
Package	4A-research	4E-expl.	4E-research
Al_2O_3	-	0.01%	0.01%
CaO	-	0.01%	0.01%
Fe_2O_3	-	0.01%	0.01%
K_20	-	0.01%	0.01%
MgO	-	0.01%	0.01%
MnO	-	0.01%	0.01%
Na_2O	-	0.01%	0.01%
P_2O_5	-	0.01%	0.01%
SiO_2	-	0.01%	0.01%
TiO_2	-	0.01%	0.01%
LOI	-	0.01%	0.01%
Ag	2	0.5	0.5
As	1	2	1
Au	2 ppb	5 ppb	1 ppb
Ba	20	3	1
Be	-	1	1
Bi	-	2	2 (0.1 ‡‡)
Br	0.5	1	0.5
Ca	0.2%	-	-
Cd	-	0.5	0.5
Co	0.1	1	0.1
Cr	0.5	1	0.5
Cs	0.2	0.5	0.2 (0.1 ‡‡)
Cu	-	1	1
Fe	0.01%	-	-
Ga	-	(5 ‡)	(5 ‡) (1 ‡‡)
Ge	-	-	(0.5 ‡‡)
Hf	0.2	0.5	0.2 (0.1 ‡‡)
Hg	-	1-1000ppm	1-1000ppm
In	-	-	(0.1 ‡‡)
Ir	2 ppb	2	2
Mo	2	5	2
Na	0.001%	-	-
Nb	-	(1 ‡)	(1 ‡) (0.2‡‡)
Ni	50	1	1
Pb	-	(5 ‡)	(5 ‡)
Rb	10	20 (2 ‡)	10 (2 ‡) (1 ‡‡)
S	-	0.001%	0.001%
Sb	0.1	0.2	0.1
Sc	0.01	0.1	0.01
Se	0.5	3	0.5
Sn	-	(5 ‡)	(5 ‡) (1 ‡‡)
Sr	100	2	2
Ta	0.3	1	0.3 (0.01‡‡)
Th	0.1	0.5	0.1 (0.05 ‡‡)
Tl	-	-	(0.05 ‡‡)
U	0.1	0.5	0.1 (0.01 ‡‡)
V	-	5	5
W	1	3	1
Y	-	1	1
Zn	10	2	2
Zr	-	4	4 (1 ‡‡)
La	0.05	0.5	0.05
Ce	1	3	1 (0.05 ‡‡)
Pr	(0.01 †)	-	(0.01 ‡‡)
Nd	1	5	1 (0.05 ‡‡)
Sm	0.01	0.1	0.01
Eu	0.05	0.1	0.05 (0.005 ‡‡)
Gd	(0.01 †)	-	(0.01 ‡‡)
Tb	0.1	0.5	0.1 (0.01 ‡‡)
Dy	(0.01 †)	-	(0.01 ‡‡)
Ho	(0.01 †)	-	(0.01 ‡‡)
Er	(0.01 †)	-	(0.01 ‡‡)
Tm	(0.01 †)	-	(0.005 ‡‡)
Yb	0.05	0.1	0.05 (0.01 ‡‡)
Lu	0.01	0.05	0.01 (0.002 ‡‡)
1-10 Samples	$73.95	$59.10	$128.75
11+ Samples	$69.70	$53.65	$118.15

Research designation: indicates lower detection limits.

Code 4A-research: Grades are determined by INAA. A minimum sample weight of 2 g is recommended. REE chondrite plots are provided at no charge.

- † **Code 4A RES-MS**: elements indicated by † are analyzed by fusion ICP-MS.

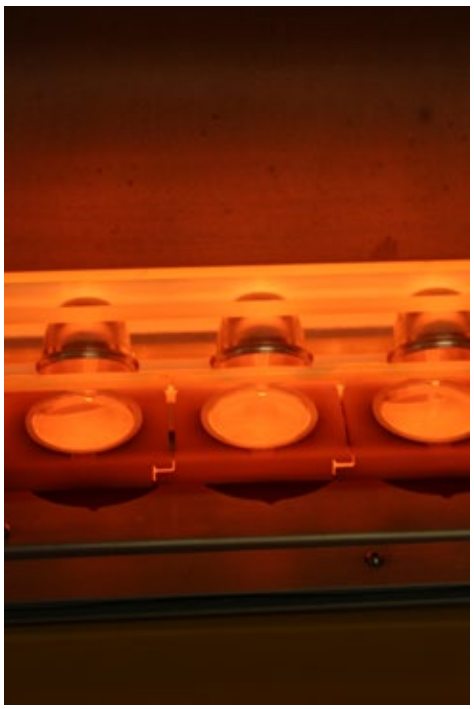
Code 4E: This package uses ICP and INAA technologies to completely characterize geological samples. This package is not suitable for analyzing concentrates or mill products. A minimum sample weight of 5 g is required.

Code 4E Add-Ons

- ‡ **Code 4E-XRF** elements Ga, Pb, Sn, Nb and Rb are examined by Pressed Pellet XRF. This package can be added to Code 4E exploration or Code 4E research (please add 6 g of sample).
- ‡‡ **Code 4E ICP-MS** add-on option: can only be added to Code 4E research grade.

Code 4F: Other analyses associated with WRA (can be added to any Code 4 package). Add 1 gram for each option chosen (see page 16).

All elements are in ppm except where noted. Prices per sample.



Peroxide "Total" Fusion

Peroxide Fusions: Sodium peroxide fusion will result in a total metal recovery. It is effective for the decomposition of sulphides and refractory minerals. For nickel sulphide deposits this is the preferred method. This method is not suitable if sodium is required. Code 8 4-Acid is recommended if sodium is required.

ICP-OES+ICP-MS (ppm)			
Package Ultratrace 7			
Al	0.01 - 25%	Mo	1 - 10,000
As	5 - 10,000	Nb	2.4 - 5,000
B	10 - 10,000	Nd	0.4 - 5,000
Ba	3 - 10,000	Ni	10 - 10,000
Be	3 - 5,000	Pb	0.8 - 5,000
Bi	2 - 5,000	Pr	0.1 - 1,000
Ca	0.01 - 40%	Rb	0.4 - 5,000
Cd	2 - 5,000	S	0.01 - 25%
Ce	0.8 - 5,000	Sb	2 - 5,000
Co	0.2 - 5,000	Se	8 - 5,000
Cr	30 - 10,000	Si	0.01 - 30%
Cs	0.1 - 5,000	Sm	0.1 - 1,000
Cu	2 - 10,000	Sn	0.5 - 10,000
Dy	0.3 - 5,000	Sr	3 - 10,000
Er	0.1 - 5,000	Ta	0.2 - 10,000
Eu	0.1 - 1,000	Tb	0.1 - 1,000
Fe	0.05 - 30%	Te	6 - 10,000
Ga	0.2 - 5,000	Th	0.1 - 1,000
Gd	0.1 - 5,000	Ti	0.01 - 25%
Ge	0.7 - 5,000	Tl	0.1 - 1,000
Hf	10 - 5,000	Tm	0.1 - 1,000
Ho	0.2 - 1,000	U	0.1 - 10,000
In	0.2 - 1,000	V	5 - 10,000
K	0.1 - 25%	W	0.7 - 5,000
La	0.4 - 10,000	Y	0.1 - 1,000
Li	15 - 10,000	Yb	0.1 - 1,000
Mg	0.01 - 30%	Zn	25 - 10,000
Mn	3 - 10,000	-	-
Price:	$43.20		

Halogens

Halogen analysis is a great tool to aid with exploration. We offer halogen analysis by INAA (short-lived isotopes) or by fusion.

Code	Method	Detection Limit/Range	Price:
4F-Cl	INAA	0.01%	$32.65
4F-Cl (XRF)	Lithium Borate Fusion with XRF	0.005-5%	$22.90
4F-F (KOH)	KOH Fusion	20-20,000	$26.10
4F-F*	Lithium Borate Fusion with Ion Selective Electrode	0.01%	$24.55
5S-Br	Short Lived Isotopes	5-10,000	$43.00

All elements are in ppm except where noted. Prices per sample.

*results may not be total and will be dependent on mineralogy in the sample

Mercury

Package	Method	Detection Limit	Price
1G	Cold Vapour FIMS	5ppb	$11.80

Miscellaneous Analysis

Code	Method	Detection Limit/Range	Price:
4F-B	by PGNAA	2	$44.65
4F-B	by PGNAA	0.5	$54.60
4F-Gd	by PGNAA	0.5	$44.65
4F-FeO	by Titration	0.1%	$18.45
4F-H_2O	Gravimetric and IR	0.1%	$24.80
4F-N	(Total)	-	$43.25

All elements are in ppm except where noted. Prices per sample.

*results may not be total and will be dependent on mineralogy in the sample

Carbon/Sulpur Species, Acid Rock Drainage

Carbon & Sulphur Species

Determining carbon and sulphur species can provide valuable information on mineralogy, metallurgy, and environmental issues pre- and post-project evaluation.

Carbon & Sulpur Species	
Package	**Price:**
4F - C,S (0.01%) by IR	$21.60
4F - C-Organic (0.5%) by IR (calc)	$51.75
4F - C-Organic (0.02%) (non carbonate carbon)	$31.50
4F - C-Total (0.01%) by IR	$16.65
4F - C-Graphitic (0.05%) by IR	$27.00
4F - $CaCO_3$ by IR (calc)	$28.60
4F - CO_2 (0.01%) by IR	$19.80
4F - S (0.01%) by IR	$16.65
4F - SO_3 (0.3%) by IR	$23.65
4F- SO_4 (0.05%) by IR	$23.65
4F- S^{2-} (0.01%) by IR	$23.65
4F-LOI	$10.35

5G - Carbon & Sulphur/Metallurgical Balance Package		
Element	**Detection Limit**	**Price / Sample**
C-Total	0.01%	$93.80
C-Graphitic	0.05%	
C-Organic	0.5%	
CO_2	0.01%	
S	0.01%	
SO_4	0.05%	

Acid Rock Drainage

Code 11: Acid-Base Accounting: Acid Base Accounting (ABA) is used to make static measurements of Acid Rock Drainage potential. Measurements of total sulphur or sulphide sulphur are used to estimate the amount of acid bearing material. Using this information, the Neutralization Potential (NP), Acid Producing Potential (AP) and Net Neutralization Potential (Net NP) are reported.

The Sobek package is the original method described by Sobek for the US EPA. The Modified Sobek package is that by Lawrence and Wang. The Siderite correction package applies a method to limit the overestimation of Net NP in the Sobek method caused by the presence of siderite.

ABA packages			
Parameter	**11-Acid/Base Package**	**11-Acid/Base Enhanced Package**	**11-Acid/Base Supreme Package**
AP	•	•	•
NP	•	•	•
Net NP	•	•	•
MPA	•	•	•
NP: MPA Ratio	•	•	•
Paste pH	•	•	•
Sulphur (total)	•	•	•
Acid Soluble Sulphate		•	•
Sulphide		•	•
Sulphate (total)			•
CO_2			•
Sobek Package	$81.00	$108.00	$151.20
Modified Sobek Package	$135.00	$161.10	$207.00
Siderite Correction Package	$135.00	$161.10	$207.00

Code 11: Net Acid Generation (NAG)
A direct oxidation method used to estimate the acid forming potential of a sample. The sample is reacted with hydrogen peroxide to oxidize any sulphide minerals present. The sample must be acid generating and not acid neutralizing. This causes acid generation and acid neutralization to occur simultaneously, with the end result being a direct measurement of the net amount of acid a sample can generate. If the reacted sample has a pH of 4.5 or less it is likely to be acid generating. Titration of the mixture is used to determine the amount of acidity generated. False positive results may occur if a high organic content is present. This false positive can be identified by combination with a NAPP test. In order to analyze for metals in the leachate a full second leach must be performed. Therefore, the procedure will be charged twice.

Price per sample: $118.15
Price per sample with NAG and NAPP: $226.80

Code 11: Acid Neutralizing Capacity (ANC)
Acid buffering inherent to the sample caused by a reaction of produced acid with other minerals contained within the sample. The ANC is determined using the Modified Sobek Method. A known amount of hydrochloric acid is added to a sample and allowed to react. The sample is then back-titrated with sodium hydroxide to determine the amount of unreacted HCl. The amount of acid consumed by the reaction with the sample is calculated and expressed as kg H2SO4/t.

Price per sample: $151.20

Code 11 – Net Acid Production Potential (NAPP)
Amount of acid potentially produced by a sample after allowing for inherent neutralizing capacity (ANC). The NAPP is calculated using the formula: NAPP = Maximum Potential Acidity – ANC.

Refer to ANC and ABA for pricing.

Code 12 – Leachate Quality			
Parameters	**Leachate Extraction & Analysis**	**Parameters**	**Leachate Extraction & Analysis**
SWEP	•	EPA (includes metals and Hg)	•
TCLP	•	MWEP (leach only for metals)	•
Price	On request	Price	On request

Selective Extractions

Selective Extractions (SE) are a cost-effective method of finding blind mineralization through deep cover such as exotic over burden, lake beds, barren bedrock, or younger volcanic rocks. Very subtle trace element signatures have been added to soil above mineralization by elements migrating to the surface through a variety of mechanisms. Some traps for these signatures include Mn oxides, clay, carbonates, and organic material. Varieties of Selective Extractions target different trap types to release the signal of mineralization. A weaker leach is required to isolate the signal of blind mineralization from that of the over burden. Conventional partial leaches, like aqua regia extraction- ICP, extract metals from sulphides, oxides and silicates. This provides a partial composition of the overburden which will contaminate the signal of the buried mineralization. Pattern recognition is the key to proper interpretation of SE data, since anomaly patterns can be different from conventional geochemical data. Selective extractions have been shown to work effectively in both acidic and alkaline environments, and have been used successfully in desert, tropical, glacial and permafrost terrains.

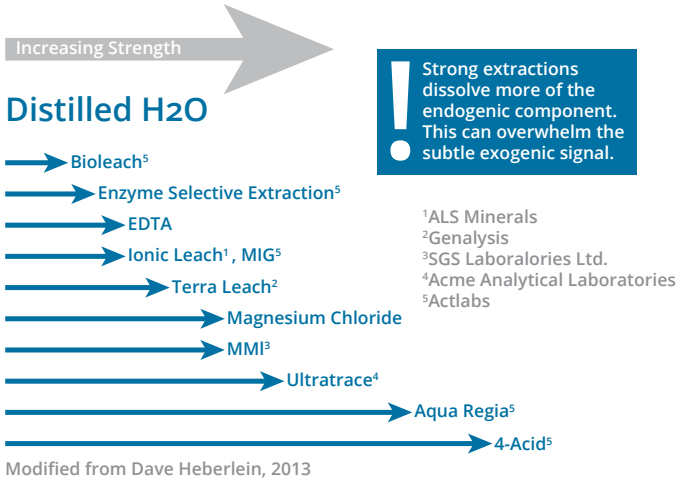
Enzyme Selective Extraction (ESE) is one of the most discriminating of the selective analytical extractions in use today. This selective extraction targets amorphous mixed oxide coatings. By selectively removing the amorphous manganese dioxide from these coatings, the mixed oxide coatings collapse, releasing trapped trace elements. At this time, the greatest depth of penetration of ESE for a mineral deposit is greater than 800 metres.

Bioleach uses technology proprietary to Actlabs. Through years of research by Actlabs, supported by CAMIRO (Canadian Mining Research Organization) with our SGH technology, it has been proven that microbiological processes are exceptionally important. Electrochemical Redox cells mobilize metals from the mineral deposit to the surface which become adsorbed on soil particles and create unique surficial conditions that bacteria then feed upon. Bioleach digests bacteria and their proteins from the collected surficial samples to analyze for the elements related to the blind mineralization.

MIG (Mobile Ion Geochemistry) isolates the chemically active metal ions which were loosely adsorbed to soil particles. This is a weak leach that uses a solution of organic and inorganic compounds to extract target elements.

Preparation and Analysis

The recommended sample material is upper B-horizon soil sampled at a continuous depth. After materials are collected, they are air dried or dried in special rooms kept below 40°C. Samples then undergo the chosen SE under rigidly controlled conditions. The resultant solutions are analyzed by ICP-MS.



Modified from Dave Heberlein, 2013

Add-ons:	Price
Final pH of leach solution	$8.75
Conductivity of leach solution	$8.75
pH and conductivity	$13.45
Prewash, if required, on high salt samples	$3.35

Tools for Buried Deposit Targets

Selective Extractions					
Package	7-ESE Enzyme SE	7-EnhESE Enhanced Enzyme	7-SaltESE High Salt	7-Bioleach	7-MIG Mobile Ion Geochem
Ag	0.2	0.1	0.2	0.2	0.2
Al	0.5ppm	0.5 ppm	0.5 ppm	0.5 ppm	0.5 ppm
As	1	0.1	5	0.5	0.5
Au	0.05	0.005	0.1	0.05	0.05
Ba	1	0.5	1	1	1
Be	2	0.1	20	0.07	0.07
Bi	0.8	0.5	1	0.1	0.1
Br	5	1	30	5	5
Ca	5 ppm	5 ppm	0.5 ppm	5 ppm	0.5 ppm
Cd	0.2	0.1	0.2	0.05	0.05
Ce	0.1	0.01	1	0.02	0.02
Cl	* 2000	* 1000	* 3000	-	-
Co	1	0.2	1	0.1	0.1
Cr	20	3	50	* 2	* 2
Cs	0.1	0.01	1	0.01	0.01
Cu	3	1	5	0.5	0.5
Dy	0.1	0.01	1	0.01	0.01
Er	0.1	0.01	1	0.01	0.01
Eu	0.1	0.01	1	0.01	0.01
Fe	1 ppm	1 ppm	1 ppm	1 ppm	1 ppm
Ga	1	0.3	1	0.1	0.1
Gd	0.1	0.01	1	0.03	0.03
Ge	0.5	0.05	1	0.05	0.05
Hf	0.1	0.01	1	0.04	0.04
Hg	* 1	* 0.1	* 1	* 0.05	* 0.05
Ho	0.1	0.01	1	0.01	0.01
I	2	1	10	1	1
In	0.1	0.01	0.2	0.1	0.1
K	5 ppm	5 ppm	5 ppm	5 ppm	5 ppm
La	0.1	0.01	1	0.01	0.01
Li	* 2	* 0.5	* 10	* 0.2	* 0.2
Lu	0.1	0.01	1	0.01	0.01
Mg	2 ppm	2 ppm	2 ppm	2 ppm	2 ppm
Mn	1	0.4	10	0.1	0.1
Mo	1	0.1	1	2	2
Na	5 ppm	5 ppm	-	-	-
Nb	1	0.1	1	0.2	0.2
Nd	0.1	0.01	1	0.03	0.03
Ni	3	1	5	0.2	0.2
Pb	1	0.1	1	0.1	0.1
Pr	0.1	0.01	1	0.01	0.01
Pt	1	0.5	1	0.5	0.5
Pd	1	0.5	1	0.5	0.5
Rb	1	0.1	1	0.1	0.1
Re	0.01	0.005	0.1	0.01	0.01
Ru	1	0.5	1	0.05	0.05
Sb	0.1	0.01	1	0.2	0.2
Sc	*100	*10	*1000	*0.5	*0.5
Se	5	1	30	1	1
Sm	0.1	0.01	1	0.03	0.03
Sn	0.8	0.2	1	-	-
Sr	1	0.1	1	0.1	0.1
Ta	0.1	0.02	1	0.01	0.01
Tb	0.1	0.01	1	0.01	0.01
Te	1	0.5	1	1	1
Th	0.1	0.01	1	0.02	0.02
Ti	* 100	* 10	* 1000	-	-
Tl	0.1	0.005	1	0.2	0.2
Tm	0.1	0.01	1	0.01	0.01
U	0.1	0.01	1	0.01	0.01
V	1	0.1	5	1	1
W	1	0.1	1	0.01	0.01
Y	0.5	0.05	1	0.02	0.02
Yb	0.1	0.01	1	0.02	0.02
Zn	10	5	10	2	2
Zr	1	0.1	1	0.5	0.5
Price:	$34.25	$43.00	$43.00	$31.20	$31.20

All elements are in ppb except where noted.

* Semi-Quantitative

Tools for Buried Deposit Targets

Sequential Leaches

Sequential leaches can target specific soil or rock phases and allow a better interpretation of the geochemical processes involved. A sample will undergo sequential leaching process starting with the weakest leach to the strongest leach with subsequent analysis of each of the leachates by ICP-MS.

Some of the potential leaches which can be combined sequentially include from the weakest to the strongest:

Code 7 - Deionized Water	This water soluble leach attacks any water soluble component or most labile bound components. The leach is not buffered and can be affected by buffering the sample mineralogy.
Code 7 - Enzyme SE	Selectively goes after amorphous Mn oxides
Code 7 - Bioleach	A leach proprietary to Actlabs that has been designed
Code 7 - Sodium Acetate Leach pH 5	For exchangeable cations adsorbed by clay and elements co-precipitated with carbonates
Code 7 - Sodium Pyrophosphate Leach	0.1M leach for elements adsorbed by organic material (humic and fulvic components)
Code 7 - MIG Leach	For mobile metal components
Code 7 - Hydroxylamine Leach Cold	For amorphous Fe oxides and crystalline Mn oxides
Code 7 - Hydroxylamine Leach Hot	For amorphous and crystalline Fe oxides and crystalline Mn oxides.
Code 7 - Aqua Regia	Will leach sulphide species and clay minerals
Code 7 - Four Acid	Will dissolve silicate remnant material

Price: $43.00 / leach / sample (unless otherwise listed)

Note: There is a $214.30 set-up charge per leach chosen if there are under 10 samples.

Add-ons:	Price
Final pH of leach solution	$8.75
Conductivity of leach solution	$8.75
pH and conductivity	$13.45

Tools for Buried Deposit Targets

Sequential Leaches					
Package	7-Sodium Pyrophosphate Leach	7-Sodium Pyrophosphate HR-Leach	7-Sodium Acetate Leach	7-Hydroxylamine Leach	7-De-ionized water Leach
Ag	500	8	5	10	0.1
Al	10 ppm	-	5 ppm	10 ppm	0.5 ppm
As	300	160	30	40	0.1
Au	5	28	5	5	0.005
B	-	970	-	-	-
Ba	300	16	1000	50	0.5
Be	50	4	10	20	0.1
Bi	40	1	10	100	0.5
Br	300	2009	500	2000	1
Ca	500 ppm	20	200 ppm	700 ppm	5 ppm
Cd	20	1	10	5	0.1
Ce	40	8	3	2	0.01
Cl	-	-	-	-	* 1000
Co	50	4	5	5	0.2
Cr	* 500	* 24	* 100	* 5000	3
Cs	2	4	2	5	0.01
Cu	600	40	100	40	1
Dy	5	0.1	2	1	0.01
Er	1	0.1	1	1	0.01
Eu	5	0.1	1	0.5	0.01
Fe	50 ppm	400	5 ppm	10 ppm	1 ppm
Ga	20	4	10	5	0.3
Gd	5	0.1	1	1	0.01
Ge	300	4	5	10	0.05
Hf	5	0.4	2	5	0.01
Hg	* 200	* 160	* 20	* 20	* 0.1
Ho	1	0.04	0.5	0.5	0.01
I	1000	80	100	200	1
In	2	0.4	1	0.5	0.01
K	50 ppm	4000	20 ppm	50 ppm	5 ppm
La	20	8	2	2	0.01
Li	* 1000	* 120	* 100	* 50	* 0.5
Lu	1	0.04	0.5	0.5	0.01
Mg	10 ppm	800	5 ppm	10 ppm	2 ppm
Mn	300	400	100	40	0.4
Mo	40	16	20	20	0.1
Na	-	-	-	50 ppm	5 ppm
Nb	20	0.4	1	0.5	0.1
Nd	20	0.4	2	2	0.01
Ni	1000	200	30	80	1
Pb	1000	12	40	20	0.1
Pr	5	0.1	0.5	0.5	0.01
Pt	100	-	100	100	0.5
Pd	100	-	100	100	0.5
Rb	20	20	20	10	0.1
Re	1	0.4	0.5	0.5	0.005
Ru	100	-	100	100	0.5
Sb	20	4	5	5	0.01
Sc	* 300	* 40	* 200	* 200	*10
Se	700	600	600	200	1
Sm	10	1	2	2	0.01
Sn	-	24	10	100	0.2
Sr	100	40	100	100	0.1
Ta	3	2	1	0.5	0.02
Tb	1	0.1	1	0.5	0.01
Te	200	4	50	10	0.5
Th	100	0.1	1	0.5	0.01
Ti	-	* 40	* 400	* 500	* 10
Tl	100	0.4	0.5	1	0.005
Tm	1	0.4	1	0.5	0.01
U	200	0.4	1	0.5	0.01
V	200	2	20	500	0.1
W	30	4	10	5	0.1
Y	10	1	1	0.5	0.05
Yb	2	0.2	3	0.5	0.01
Zn	1000	1600	2000	500	5
Zr	100	4	80	400	0.1
Price:	$43.00	$53.65	$43.00	$43.00	$43.00

All elements are in ppb except where noted.

* Semi-Quantitative

Tools for Buried Deposit Targets

SGH is a proven innovation to look for mineralization under a wide variety of cover. It is a nano-technology that has been used successfully in over 1,100 surveys.

Please contact us at **SGH@actlabs.com** or **1.888.228.5227** for more information and for a custom quotation.

Spatiotemporal Geochemical Hydrocarbons (SGH)

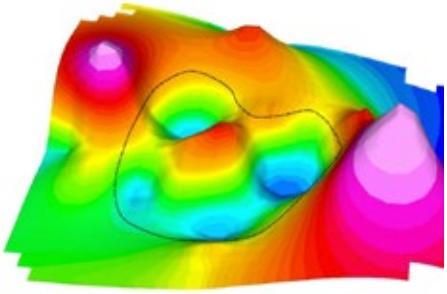
SGH is a dual-purpose geochemistry as it identifies and locates targets at depth as a vertical projection and has been used to successfully discover new previously un-drilled mineral deposits. SGH has been shown to be very robust to the use of different sample types even "within" the same survey or transect. This capability has been vital to the successful use of SGH in areas of difficult terrain. This enables the interpretation of a regular grid or set of transects as samples do not have to be missed due to the different sample types encountered.

Sample Type and Survey Design: A minimum of 50 sample locations per target is required to ensure that enough locations are used in a survey to obtain sufficient samples into background areas on both sides of small targets. More samples are recommended for large targets. SGH can also be used in regional surveys. Enough samples over both the target and background areas is critical in order to fully study the dispersion patterns or geochromatography of the SGH Pathfinder Classes of compounds. Samples should be "fist" sized (50-100 grams), can be drip dried in the field, and do not need special preservation for shipping.

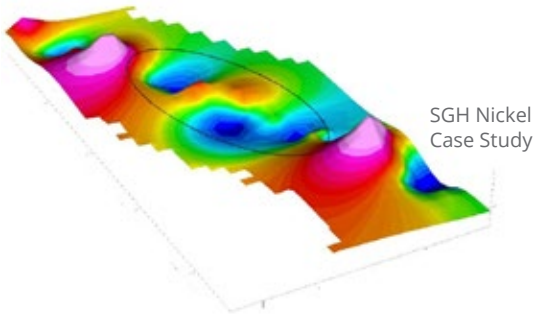
Pricing for SGH: $45.35 per sample. For large surveys volume discounts may apply, please inquire. Relative or UTM sample coordinates must accompany the samples when submitted to allow development of the SGH interpretation report. Please contact us to help you design your sampling program at no additional cost, in order to obtain the best possible SGH results for your survey. Pricing includes the delivery of an SGH interpretation report for one commodity type (e.g. Cu, Ni, Au, U, Kimberlite, etc.), for more complex targets (e.g. VMS, SEDEX, Polymetallic, IOCG, IOCGU, Cu-Au Porphyry, etc), **an extra price of $472.50** is applied to cover the time for the additional interpretation required.

Sample preparation charges are additional (Code SGH-1).

SGH Case Study Examples *



SGH Copper-Nickel-PGE Case Study



SGH Nickel Case Study

* Many more case studies available; including for other commodities.

Biogeochemistry

Code 2A - Humus

Code 2B - Vegetation: INAA provides a very cost effective, rapid means of analyzing humus or vegetation to very low detection limits for gold and many other elements useful for geochemical exploration. The organic material is dried below 60°C, macerated and a 15 g aliquot is compressed into a briquette and analyzed using Code 2A or Code 2B depending on whether the material is purely organic (Code 2B) or contains mineral matter (Code 2A). These briquettes are irradiated and their gamma ray spectra are measured and quantified. The advantages of this technique are simplicity (less chance of human error and contamination, ashing is costly and the results in loss of gold) and INAA is the technique with ultimate sensitivity for gold and other trace elements. Prices listed in Codes 2A and 2B are for standard 15 g briquettes. Selected elements may be available at lower costs.

Code 2C - Vegetation Ash INAA

Code 2C1 - Vegetation Ash-ICP-OES: Prices for Code 2C1 for single element is **$6.15** with each additional element costing **$2.60**.

Code 2D - Vegetation Ash-ICP-MS: Some geologists prefer ashing samples at low temperature (480°C) and determining metals on the ash. This may be advantageous, particularly if base metals are also required for your gold project or for base metal exploration. Note when samples are ashed, there may be volatile loss of certain elements (Au, As, Br, Hg, Cd, etc). Results are reported on an as received basis. Code 2D uses a proprietary acid digestion on the ash followed by ICP-MS and extends the list of elements which are available. Not all elements may be total. This package can be quite useful for diamond exploration.

Code 2E: This package is similar to Code 2D but requires a different digestion of the plant ash to obtain Au, Pt and Pd to low levels. This method has been shown to be very effective for PGE exploration.

Code 2F: Dry vegetation samples are dissolved in acid and analyzed by High Resolution ICP-MS.

Code 2G: Dry vegetation samples are dissolved in acid and analyzed by ICP-MS.

Actlabs only ashes vegetation in dedicated vegetation ashing furnaces to avoid contamination.

	Humus INAA	Vegetation INAA	Ash Package INAA	Base Metal Vegetation Aqua Regia-ICP	Ash Package Digestion ICP-MS	Ash Package ICP-MS Au+Pt+Pd	Vegetation Unashed ICP-MS	Vegetation Unashed HR-ICP-MS
Package	Code 2A	Code 2B	Code 2C	Code 2C1	Code 2D	Code 2E	Code 2G	Code 2F
Ag	2	0.3 ppb	2	0.2	0.2	0.2	3	1
Al	-	-	-	-	2	2	4 ppm	-
As	1	0.01	0.5	-	1	3	10	5
Au	1 ppb	0.1 ppb	5 ppb	-	-	5 ppb	0.2	0.1
B	-	-	-	-	5	5	1 ppm	200
Ba	100	5	50	-	3	3	100	1 ppm
Be	-	-	-	-	0.005	0.08	30	0.1
Bi	-	-	-	-	0.05	0.05	2	1
Br	1	0.01	1	-	-	-	-	-
Ca	0.5%	0.01%	0.2%	-	0.1%	0.1%	25 ppm	2 ppm
Cd	-	-	-	-	0.01	0.01	6	0.1
Ce	1	0.1	3	-	0.01	0.01	15	0.5
Co	1	0.1	1	-	0.01	0.01	4	0.5
Cr	1	0.3	1	-	1	10	100	10
Cs	0.5	0.05	0.5	-	0.001	0.001	0.2	0.1
Cu	-	-	-	1	0.2	0.2	50	20
Dy	-	-	-	-	0.001	0.001	0.5	0.05
Er	-	-	-	-	0.001	0.001	0.4	0.05
Eu	0.2	0.05	0.01	-	0.001	0.001	0.2	0.1
Fe	0.05%	0.005%	0.05%	-	0.01%	0.01%	3 ppm	0.5 ppm
Ga	-	-	-	-	0.1	0.1	4	0.5
Gd	-	-	-	-	0.01	0.01	0.4	1
Ge	-	-	-	-	0.1	0.1	3	10
Hf	0.5	0.05	0.5	-	0.01	0.01	0.4	2
Hg	0.5	0.05	1	-	-	-	2	5
Ho	-	-	-	-	0.001	0.001	0.2	0.01
In	-	-	-	-	1 ppb	1 ppb	0.2	0.1
Ir	5 ppb	0.1 ppb	2 ppb	-	-	-	-	-
K	-	0.01%	0.05%	-	0.01%	0.01%	10 ppm	10 ppm
La	0.1	0.01	0.1	-	0.002	0.002	10	0.2
Li	-	-	-	-	0.5	0.5	10	5
Lu	0.1	0.001	0.05	-	0.001	0.001	0.5	0.2
Mg	-	-	-	-	0.01%	0.01%	2 ppm	0.5 ppm
Mn	-	-	-	1	0.1	0.1	100	10
Mo	0.5	0.05	2	1	0.1	0.1	10	1
Na	100	1	10	-	0.01%	0.01%	5 ppm	10 ppm
Nb	-	-	-	-	0.005	0.005	2	0.5
Nd	3	0.3	5	-	0.002	0.002	5	0.2
Ni	10	2	50	1	5	5	50	0.1 ppm
P	-	-	-	-	-	-	4 ppm	-
Pb	-	-	-	1	0.1	0.1	50	10
Pd	-	-	-	-	-	3 ppb	0.2	2
Pr	-	-	-	-	0.002	0.002	1	0.5
Pt	-	-	-	-	-	2 ppb	0.2	2
Rb	20	1	5	-	0.01	0.01	10	10
Re	-	-	-	-	0.1 ppb	0.1 ppb	0.2	0.1
Rh	-	-	-	-	-		-	-
Ru	-	-	-	-	-	10 ppb	-	-
Sb	0.1	0.005	0.1	-	0.02	0.02	10	0.2
Sc	0.1	0.01	0.1	-	0.5	0.5	-	1
Se	2	0.1	2	-	1	10	100	0.2 ppm
Si	-	-	-	-	0.2%	0.2%	-	-
Sm	0.1	0.001	0.1	-	0.001	0.001	1	0.1
Sn	-	-	-	-	-	1	50	40
Sr	100	10	300	-	0.1	0.1	40	20
Ta	0.5	0.05	0.5	-	0.001	0.001	0.2	0.1
Tb	0.2	0.1	0.5	-	0.001	0.001	0.2	0.02
Te	-	-	-	-	0.01	0.01	8	1
Th	0.5	0.1	0.1	-	0.001	0.001	2	5
Ti	-	-	-	-	1	1	150	20
Tl	-	-	-	-	0.001	0.001	1	0.5
Tm	-	-	-	-	0.001	0.001	0.1	0.05
U	0.1	0.01	0.1	-	0.001	0.001	1	1
V	-	-	-	-	1	10	10	10
W	1	0.05	1	-	0.5	0.5	25	5
Y	-	-	-	-	0.001	0.001	2	0.2
Yb	0.1	0.005	0.05		0.001	0.001	0.4	0.4
Zn	20	2	50	1	1	1	400	0.2 ppm
Zr	-	-	-	-	0.5	0.5	20	5
Price	$21.75	$25.50	$23.65	$11.90	$29.70	$36.40	$37.80	On Request
						5g Price	$42.30	

Codes 2A, 2B, 2C, 2C1, 2D, 2E: all elements are in ppm, except where noted.
Codes 2F, 2G: all elements are in ppb, except where noted.

Hydrogeochemistry

All detection limits are in µg/L except where noted for naturally occurring waters with low TDS <0.05%

Code 6 is applicable only to natural waters with low total dissolved solid content (<0.05%). Any individual cations greater than the dynamic range of the ICP-MS will be reported as (>) unless the Overrange option is chosen. Samples submitted under all Code 6 packages (with exception of Code 6 Dissolved and Code 6 Total Recoverable mentioned below) will be analyzed on the supernatant portion of waters as received, acidified to pH <2 without filtration or digestion. The Code 6 Dissolved package includes filtration with 0.45µ filters while the Code 6 Total Recoverable Natural Waters package include water digestion according to EPA protocols. Samples will be analyzed on the supernatant portion of waters as received, acidified to pH <2 without filtration. For hydro samples being analyzed by ICP-MS or by Ion Chromatography, please include field TDS/conductivity measurements, if available.

Actlabs' unique High Resolution ICP-MS water package provides unrivaled sensitivities for hydrogeochemical surveys on natural waters with low TDS.

From Eppinger et al., 2013: 'Anomalous concentrations of Ag, In, Sb, Th, U, W fall in the exceedingly low ng/l concentrations ranges discernible only with the HR-ICPMS method'. Only HR-ICP-MS could see the deeply-buried Pebble Porphyry Copper Deposit.

Water: *'Lower determination limits for cations analyzed by HR-ICP-MS, a relatively new technique available commercially since around 2005, are commonly two and perhaps three orders of magnitude below those by standard ICP-MS. As a consequence, the resulting dataset is robust and has few highly censored elements (i.e., those with "less than" values), an unusual feature for water analyses. The lower determination limits for elements analyzed by HR-ICP- MS allow observation of element patterns at exceedingly low concentrations ranges.'*

Note: The prices for these packages are on the next page.

	ICP-MS	ICP-OES	PGE HR-ICP-MS	HR-ICP-MS	Au HR-ICP-MS
Ag	0.2	5	-	0.002	-
Al	2	0.1mg/L	-	0.5	-
As	0.03	30	-	0.02	-
Au	-	-	-	-	0.1ng/L
B	3**	-	-	0.1	-
Ba	0.1	20	-	0.01	-
Be	0.1	2	-	0.001	-
Bi	0.3	20	-	0.001	-
Ca	700	0.1mg/L	-	5	-
Cd	0.01	2	-	0.001	-
Ce	0.001	30	-	0.001	-
Co	0.005	2	-	0.001	-
Cr	0.5	20	-	0.01	-
Cs	0.001	-	-	0.001	-
Cu	0.2	2	-	0.5	-
Dy	0.001	-	-	0.0005	-
Er	0.001	-	-	0.00005	-
Eu	0.001	-	-	0.00005	-
Fe	10	0.01mg/L	-	1	-
Ga	0.01	-	-	0.001	-
Gd	0.001	-	-	0.00005	-
Ge	0.1	-	-	0.001	-
Hf	0.001	-	-	0.00005	-
Hg	0.2 (0.006+)	-	-	0.05	-
Ho	0.001	-	-	0.00001	-
In	0.001	-	-	0.0001	-
Ir	-	-	1ng/L	-	-
K	30	0.1mg/L	-	1	-
La	0.001	-	-	0.001	-
Li	1	0.05mg/L	-	0.05	-
Lu	0.001	-	-	0.00005	-
Mg	2	0.1mg/L	-	0.2	-
Mn	0.1	0.01mg/L	-	0.05	-
Mo	0.1	5	-	0.005	-
Na	5	0.1mg/L	-	5	-
Nb	0.005	-	-	0.0001	-
Nd	0.001	-	-	0.0001	-
Ni	0.3	5	-	0.5	-
P	--	0.02mg/L	-	-	-
Pb	0.01	10	-	0.005	-
Pr	0.001	-	-	0.00005	-
Pd	-	-	1ng/L	-	-
Pt	-	-	0.5ng/L	-	-
Rb	0.005	-	-	0.005	-
Re	-	-	-	0.0001	-
Rh	-	-	0.5ng/L	-	-
Ru	-	-	3	-	-
S	-	1mg/L	-	-	-
Sb	0.1	10	-	0.001	-
Sc	1	-	-	0.01	-
Se	0.2	20	-	5	-
Si	200	0.1mg/L	-	-	-
Sm	0.001	-	-	0.0005	-
Sn	0.1	10	-	0.01	-
Sr	0.04	10	-	0.01	-
Ta	0.001	-	-	0.0005	-
Tb	0.001	-	-	0.00002	-
Te	0.1	10	-	0.001	-
Th	0.001	-	-	0.00002	-
Ti	0.1	10	-	0.01	-
Tl	0.001	10	-	0.0001	-
Tm	0.001	-	-	0.0001	-
U	0.001	0.05mg/L	-	0.0001	-
V	0.1	10	-	0.001	-
W	0.02	10	-	0.001	-
Y	0.003	10	-	0.0005	-
Yb	0.001	-	-	0.00005	-
Zn	0.5	5	-	0.5	-
Zr	0.01	-	-	0.001	-

All elements are in ppb except where noted.

Tools for Buried Deposit Targets

Hydrogeochemistry

The lab reserves the right to adjust the matrix of the samples to perform the testing required.

Code 6 - Hydrogeochemistry		
Package		**Prices**
Code 6 - Natural Waters with low TDS (<0.05%)	1-50 samples as received	$49.50
	51+ samples as received	$45.00
Code 6 - Total Recoverable Natural Waters with low TDS (<0.05%)	1-50 samples	$63.45
	51+ samples	$59.20
Code 6 - Dissolved Natural Waters with low TDS (<0.05%)	1-50 samples	$63.45
	51+ samples	$59.20
† **Code 6 MB** - Marine Water, Brines or other aqueous solutions with TDS > 0.05%		$76.05
Code 6 Overrange - Overrange elements in Code 6 MB reanalyzed by ICP-OES or ICP-MS if required		add $18.45
Code 6 ICP-OES - Hydrogeochemistry ICP-OES for 36 elements		$28.15
† **Code 6 ICP-OES MB** - Hydrogeochemisty ICP-OES for Marine Brines		$42.30
Code 6 Hg – Hg(+) option on separate sample by FIMS		add $24.55
Code 6 Boron - Boron add-on by ICP-MS		add $7.20
Code 6 Filter - Samples filtered with 0.45µ filter		add $15.30
Code 6 EXPER - Where % RSDs are required (1-4 elements only)		$64.35
Code 6 COC - Where Chain-of-Custody for legal defense is required		$67.50
Code 6 Au HR-ICP-MS - Au by High Resolution ICP-MS		$76.50
Code 6 HR-ICP-MS - Water analysis by High Resolution ICP-MS		$117.00
Code 6 PGE HR-ICP-MS - PGE by High Resolution ICP-MS		$90.00
Code 6 Acidify - With ultrapure nitric to pH <2		$3.15

Samples submitted as natural waters, but with TDS >0.05% will be charged as 6MB.
Analysis of waste waters and other solutions are available, but at varying costs. Please inquire
† Detection limits for samples with high dissolved solids such as marine waters or brines, may be elevated by a factor of 10-1000.

Ion Chromatography

Code 6B-Ion Chromatography			
Analyte	**Detection Limit (mg/L)**	**Analyte**	**Detection Limit (mg/L)**
Fluoride (F)	0.01	Nitrate (NO3)	0.01
Chloride (Cl)	0.03	Phosphate (PO4)	0.02
Bromide (Br)	0.03	Sulphate (SO4)	0.03
Nitrite (NO2)	0.01		

First analyte: $25.45 | Each additional: $17.55 | All analytes: $64.35

Miscellaneous Analyses

Miscellaneous Analyses		
Code 6C		**Price**
Acidity		$21.60
Alkalinity ($CaCO_3$) [includes carbonate (CO_3) & bicarbonate (HCO_3)]		$21.60
Biological Oxygen Demand (BOD)		$34.65
Bisphenol A (BPA)		$66.15
BTEX (Benzene Toluene Ethylbenzene Xylene)		$45.45
Chemical Oxygen Demand (COD)		$34.65
Colour		$17.55
Conductivity		$7.20
Cyanide (Total CN)		$34.65
Cyanide (Free CN)		$34.65
Cyanide (Weak Acid Dissociable - WAD CN)		$34.65
Dissolved Oxygen (DO)		$28.60
Glycols (Propylene & Ethylene)		$42.50
Hardness (must also do Code 6 ICP-OES)		$11.25
Microbiology (E.coli, Total Coliforms, Fecal Coliforms, Heterotrophic Plate Count)		$40.95
NH_3 + NH_4 (must provide pH or also do Code 6C pH)		$34.65
Oil and Grease (Total)		$58.05
Oil and Grease (Mineral)		$40.95
Oil and Grease (Vegetable)		$40.95
PCBs (Total)		$61.45
pH		$8.35
Phthalates		$89.80
Polyaromatic Hydrocarbons (PAH/PNA - 16 compounds)		$168.30
Reactive Silica		$23.65
Salinity		$21.60
Sulphur (Elemental)	1-5 samples	$70.90
	6+ samples	$56.70
Total Dissolved Solids (TDS) (ISE)		$21.60
Total Dissolved Solids (TDS) (Grav)		$43.20
Total Kjeldahl Nitrogen (TKN)		$34.65
Total Organic Carbon (TOC)		$34.65
Total Petroleum Hydrocarbon (TPH-GRO/DRO) - C6-C10/C10-C28 for Gasoline/Diesel Range		$118.15
Total Phosphorous		$17.55
Total Suspended Solids (TSS)		$23.65
Trihalomethanes (THM)		$45.45
Turbidity		$11.25

Ores, Concentrates, and Commodities

Ore-Assays

Assays provide quantitative determinations of elements in non-processed geological materials. Assays are usually required when samples are known or suspected to contain higher levels of metals. For lower levels, geochemical methods should be used. Prices listed in our fee schedule are for natural geologic materials and are not for metallurgical products. Metallurgical products such as heads and concentrates are handled separately to prevent contamination in the laboratory. These materials are charged at three times the prices listed in our fee schedule.

Note: Aqua Regia and 4-acid Assays may not be total due to the mineralogy present in the samples.

Note: Additional elements can be analyzed upon request

8-AR-ICP Assays	
Elements	Detection Limts
Ag	3-1000 ppm
As	0.01 %
Cd	0.003 %
Co	0.003 %
Cu	0.001 %
Fe	0.003 %
Hg	0.001 %
Ni	0.003 %
Pb	0.003 %
Zn	0.001 %
One Element Each	$12.50
Additional Element	$2.15
All Elements	$17.50

8-4 Acid ICP Assays	
Elements	Detection Limts
Ag	3 ppm
Cd	0.003 %
Co	0.003 %
Cu	0.001 %
Li	0.001%
Mo	0.003 %
Ni	0.003 %
Pb	0.003 %
Zn	0.001 %
One Element Each	$14.40
Additional Element	$2.20
All Elements	$19.95

8-Peroxide Assays		
Package	8-Peroxide ICP-OES	8-Peroxide ICP-OES + ICP-MS
Al	0.01 %	0.01 %
As*	0.01-2 %	0.001 - 2 %
Be	0.001 %	0.001 %
Bi	-	0.001 %
Ca	0.01 %	0.01 %
Co	0.002 %	0.001 %
Cr	0.01 %	0.01 %
Cs	-	0.001 %
Cu	0.005 %	0.001 %
Fe	0.05 %	0.05 %
Ga	-	0.001 %
Ge	-	0.001 %
In	-	0.001 %
K	0.1 %	0.1 %
Li	0.01 %	0.01%
Mg	0.01 %	0.01 %
Mn	0.01 %	0.01 %
Mo	-	0.001 %
Nb	-	0.001 %
Ni	0.005 %	0.001 %
Pb	0.01 %	0.001 %
Re	-	0.001 %
S	0.01 %	0.01 %
Sb	0.01 %	0.002 %
Se	-	0.001 %
Si	0.01 - 47 %	0.01 - 47 %
Sn	-	0.001 %
Ta	-	0.001 %
Te	-	0.001 %
Th	-	0.001 %
Ti	0.01 %	0.01 %
Tl	-	0.001 %
U	-	0.001 %
W	0.005 %	0.001 %
Zn	0.01 %	0.001 %
One Element Each	$17.55	$25.00
Each Additional Element	$3.40	$3.40
All Elements	$29.70	$34.65

*As >2% requires a special fusion, price on request
For concentrates, titration may be applicable. Please inquire.
For Code 8 - Peroxide ICP-OES - for As above 10%, analysis by INAA assay is recommended.

Ores, Concentrates, and Commodities

Individual Assays (Non-Processed Geological Material)	
Element	**Price**
Alumina - Al_2O_3	$21.30
Antimony - Sb	$21.30
Arsenic - As	$21.30
Barium (Instrumental) - Ba	$21.30
Barium (Gravimetric) - Ba	$29.50
Beryllium - Be	$21.30
Bismuth - Bi	$21.30
Boron - B	$21.30
Bromine - Br	$21.30
Cadmium - Cd	$21.30
Calcium (oxide) - CaO	$21.30
Cerium - Ce	$21.30
Chlorine - Cl	$32.65
Chromium - Cr	$21.30
Cobalt - Co	$17.55
Copper – see various total and selective methods on page 31	-
Fluorine - F	$24.55
Gold - Au	See Code 1A3, p. 8
Gold-Silver (Au-Ag)	See Code 1A3-Ag, p. 8
Gallium - Ga	$21.30
Germanium - Ge	$21.30
Insolubles	$21.30
Iron (oxide) - Fe_2O_3	$18.25
Lanthanum - La	$18.25
Lead (total) - Pb	$17.55
Lead (oxide) - PbO	$24.30
Lithium - Li	$17.55
Loss on ignition - LOI	$10.35
Mercury - Hg	$19.15
Manganese (oxide) - MnO	$19.15
Magnesium (oxide) - MgO	$19.15
Moisture - H_2O	$24.80
Molybdenum (total) - Mo	$17.55
Molybdenum (oxide)	$24.35
Molybdenum (sulphide)	$24.35
Nickel - Ni	$17.55
Nickel - Ni Sulphide	$25.50
Niobium - Nb	$19.15
Phosphorous (oxide) - P_2O_5	$19.15
Platinum-Palladium-Gold (Pt-Pd-Au)	See Code 1C, p.8
Potassium (oxide) - K_2O	$19.15
Rhenium - Re (Mo concentrates	$44.55
Rhodium - Rh	See Code 1C-Rh, p. 8
Selenium - Se	$21.30
Silicon (oxide) - SiO_2	$19.15
Silver - Ag	$24.75
Sodium (oxide) - Na_2O	$19.15
Specific Gravity - S.G.	$13.85
Specific Gravity (wax encapsulation)	$19.80
Strontium - Sr	$19.15
Sulphur (Infrared)	$16.65
Sulphur (Gravimetric) - S	$29.50
Sulphate - SO_4	$23.65
Tantalum - Ta	$19.15
Tellurium - Te	$19.15
Thallium - Tl	$19.15
Thorium - Th	$19.15
Tin - Sn	$19.15
Titanium (oxide) - TiO_2	$19.15
Tungsten (oxide) - WO_3	$19.15
Uranium (oxide) - U_3O_8	$26.00
Vanadium (oxide) - V_2O_5	$19.15
Zinc (total) - Zn	$17.55

Concentrates

Code Conc: Analysis of mine concentrates is a critical step for purchase and sale of commodities as well as optimizing recoveries. Control Assays require the highest degree of accuracy and precision.

Code Conc			
Element	Range	Method	Price:
Ag	0.0-99.99%	Fire Assay – Gravimetric Finish	$115.90
Cu	0.5-100%	Titration	$125.55
Fe	10-100%	Fire Assay – Gravimetric Finish	$125.55
Pb	0.5-100%	Titration	$125.55
U	10-100%	Titration	$106.00
Zn	0.5-100%	Titration	$125.55
8-Au, Pt, Pd	>1000g/T	Fire Assay-ICP	$130.50

Bullion

Bullion			
Element	**Range**	**Method**	**Price**
Au	0.1 - 99.99%	Au-fire assay – Gravimetric finish	$122.40

For processed material, analysis is available upon request

Heavy Mineral Concentrates

Code 3A: Heavy Mineral Concentrates (Thermal Irradiation)
Heavy mineral concentrates prepared from reverse circulation drilling samples or from panned concentrates are expensive to collect. The nugget effect may require that the entire sample be analyzed to ensure that the few particles of gold which may be present can be measured. With INAA the whole concentrate can be analyzed without grinding the samples. The sample is therefore preserved for other chemical or mineralogical work. Actlabs only irradiates with thermal neutrons so as to avoid low gold values due to self-shielding effects from irradiation with epithermal neutrons. The price varies depending on the volume of concentrate to be analyzed.

There are 3 vial sizes available:
Small (2g) $21.80 | Medium (20g) $24.75 | Large (60g) $30.20
Actual weight may vary depending on mineralogy.

Code 3C: HMC Base Metals by Aqua Regia ICP
When the analyses by INAA are completed, the sample is available to determine additional elements by other analytical techniques. Code 3C is a frequently requested Aqua Regia extraction ICP-OES package (0.5g required). First element price for Code 3C is $6.70 with each additional element costing $2.25. All elements $12.40. Code 3C may require the sample to be pulverized finer, if coarser than +177 µm at an additional cost

	HMC Thermal (ppm)	HMC Base Metals (ppm)
Package	Code 3A	Code 3C
Ag	5	0.2
As	2	-
Au	5 ppb	-
Ba	200	-
Br	5	-
Ca	1%	-
Cd	-	0.5
Ce	3	-
Co	5	-
Cr	10	-
Cs	2	-
Cu	-	1
Eu	0.2	-
Fe	0.02%	-
Hf	1	-
Hg	5	-
Ir	50 ppb	-
La	1	-
Lu	0.05	-
Mn	-	2
Mo	20	2
Na	0.05%	-
Nd	10	-
Ni	200	1
Pb	-	2
Rb	50	-
S	-	100
Sb	0.2	-
Sc	0.1	-
Se	20	-
Sm	0.1	-
Sr	0.2%	-
Ta	1	-
Tb	2	-
Th	0.5	-
U	0.5	-
W	4	-
Yb	0.2	-
Zn	200	1

Actlabs offers exploration techniques for specific deposit types.

Bauxite

Code 8 - Bauxite: Li borate fusion/XRF Price: $34.20			
Elements	Detection Limits	Elements	Detection Limits
Al_2O_3	0.01 - 100 %	Na_2O	0.01 - 100 %
BaO	0.01 - 100 %	P_2O_5	0.002 - 100 %
CaO	0.01 - 100 %	SiO_2	0.01 - 100 %
Cr_2O_3	0.005 - 100 %	TiO_2	0.01 - 100 %
Fe_2O_3	0.01 - 100 %	V_2O_5	0.005 - 100 %
K_2O	0.01 - 100 %	ZrO_2	0.01 - 100 %
MgO	0.01 - 100 %	LOI 1000°C	0.01 - 100 %
MnO	0.01 - 100 %		

Option:
Code 4F - Sulphate SO4
(0.3% by Infrared)
Price: $23.65

Chromite/PGE

Chromite assays are usually combined with major oxide analysis as other elements are required for the metallurgical use of the chromite. Cr/Fe ratios are very important in assigning value to chromite as well as other deleterious elements.

Code 8 - Chromite/PGE Assay XRF Package Price: $34.20			
Elements	Detection Limits	Elements	Detection Limits
Al_2O_3	0.01%	MnO	0.01%
CaO	0.01%	Na_2O	0.01%
Cr_2O_3	0.01%	NiO	0.01%
Co_3O_4	0.01%	P_2O_5	0.01%
CuO	0.01%	SiO_2	0.01%
Fe_2O_3	0.01%	TiO_2	0.01%
K_2O	0.01%	V_2O_5	0.01%
MgO	0.01%	LOI	0.01%

PGE (ICP-OES) Option:

Au	2 - 30,000 ppb
Pt	5 - 30,000 ppb
Pd	5 - 30,000 ppb

PGE Option: $20.70

Coal

Code 8-Coal Package		
Parameter	ASTM Method	Price
Sample Preparation (up to 5 kg)	D2013	$28.60
Dry Screen Analysis (1 kg) (first fraction)	D4749	$73.95
Specific Gravity (Relative Density)	D167	$51.05
Total Moisture (TM)	D3302	$25.30
Proximate Analysis (Ash, Inherent Moisture, Volatile Matter)	D3172	$70.65
Calorific Value (CV)	D5865	$70.90
Total Sulphur	D4239	$47.25
Forms of Sulphur (including sulphates, pyritic sulphur and organic S)	D2492	$138.45
Mercury	D3684	$149.55
Equilibrium Moisture	D1412	$83.60
Ash Fusion Temperature (Reducing, Oxidizing, Combined)	D1857	$252.10
Bulk Density	-	$55.75
F in coal	-	$77.25
Cl in coal	-	$77.25
Loss on Ignition 750°C	ASTM D7348	$30.00

50% surcharge for less than 3 samples

Major and Trace Elements on ash (ppm, except where noted) **$187.60**					
Elements	Detection Limits	Elements	Detection Limits	Elements	Detection Limits
SiO_2	0.01%	Cr	5	Rb	2
Al_2O_3	0.01%	Cs	0.5	S	0.001%
Fe_2O_3	0.01%	Cu	1	Sb	0.2
MgO	0.01%	Dy	0.1	Sc	0.1
MnO	0.005%	Er	0.1	Se	3
CaO	0.01%	Eu	0.05	Sm	0.1
TiO_2	0.001%	Ga	1	Sn	1
Na_2O_5	0.01%	Gd	0.1	Sr	2
K_2O	0.01%	Ge	1	Ta	0.1
P_2O_5	0.01%	Hf	0.2	Tb	0.1
LOI	0.01%	Ho	0.1	Th	0.1
Ag	0.5	In	0.2	Tl	0.1
As	0.5	Ir	5 ppb	Tm	0.05
Au	2	La	0.1	U	0.1
Ba	2	Lu	0.01	V	5
Be	1	Mo	2	W	1
Bi	0.4	Nb	1	Y	1
Br	0.5	Nd	0.1	Yb	0.1
Cd	0.5	Ni	1	Zn	1
Ce	0.1	Pb	5	Zr	2
Co	1	Pr	0.05		

Ores, Concentrates, and Commodities

Coltan

Samples not requiring rare earths can be analyzed by fusion with lithium metaborate/tetraborate in platinum crucibles with the molten glass cast into a glass disc in platinum crucibles. These glass discs are analyzed by XRF. Generally low Ta_2O_5 detection limits can't be achieved with this package and the INAA technique is recommended for tantalum.

Coltan XRF	
Elements	**Detection Limits (%)**
Ta_2O_5	0.003
Nb_2O_5	0.003
U_3O_8	0.005
ThO_2	0.005
ZrO_2	0.003
Fe_2O_3(T)	0.01
P_2O_5	0.01
SnO_2	0.003
$Y2O_3$	0.003
WO_3	0.003
Price:	$37.80

Coltan Concentrates > 10% Nb_2O_5 + Ta2O5: **$108.00**

INAA Option	
Elements	**Detection Limits (ppm)**
Ta	0.5
Th	0.2
U	0.5
La	0.5
Ce	3
Nd	5
Sm	0.1
Eu	0.2
Yb	0.2
Lu	0.05
Price: First element	$21.60
Each additional	$1.15

Major Oxide Option Price: $25.20			
Elements	**Detection Limts**	**Elements**	**Detection Limts**
Al_2O_3	0.01%	MnO	0.005%
CaO	0.01%	Na_2O	0.01%
Cr_2O_3	0.01%	NiO	0.003%
Co_3O_4	0.005%	SiO_2	0.01%
CuO	0.005%	TiO_2	0.01%
K2O	0.01%	V_2O_5	0.005%
MgO	0.01%	LOI	0.01%

Copper

Code 8 - Total Copper		
Parameter	**Detection Limit**	**Price**
Cu – Aqua Regia Digestion – ICP-OES	0.001 %	$12.50
Cu - 4-Acid Digestion - ICP-OES	0.001 %	$14.40
Cu - Na Peroxide Fusion - ICP-OES	0.005 %	$17.55

Code 8 - Copper Oxide		
Parameter	**Method**	**Price**
Copper Oxide (carbonates)	Cu (acid soluble) by Sulphuric Acid (H_2SO_4) - leach AA	$14.60
	Cu (acid soluble) by Citric Acid leach AA	$14.60
Copper Oxide + secondary Sulphides	Cu (CN soluble) Sodium Cyanide (NaCN) - leach AA	$19.80
	Cu (Ferric Sulphate soluble) by Ferric Sulphate/H_2SO_4 leach AA	$16.60

Code 8 - Sequential Copper Leach	
Parameter	**Price**
Sequential leach using Cu (acid soluble) H_2SO_4 acid, cyanide leach and 4-acid digestion on final residue	$49.75

Other leaches may be available on request. Contact us to discuss your requirements.

Graphite

Code 8 - Graphite		
Parameter	**Detection Limits**	**Price**
C - Graphitic (Infrared)	0.05 %	$27.00
C - Total	0.01 %	$16.65
CO_2	0.01 %	$19.80
% Ash Yield		$26.80
Liberation and Grain Size (by MLA)		On request
8-Graphite	>50 %	$33.30

Industrial Minerals

Code 8 - Clay, Limestone, Dolomite, Gypsum, Phosphate **Price: $34.20**		
Elements	**Suitable for samples containing < 500 uranium.**	**Price**
Al_2O_3	0.01 - 100 %	
CaO	0.01 - 100 %	
Cr_2O_3	0.01 - 100 %	
Fe_2O_3	0.01 - 100 %	
K_2O	0.01 - 100 %	
MgO	0.01 - 100 %	
MnO	0.01 - 100 %	
Na_2O	0.01 - 100 %	
P_2O_5	0.002 - 100 %	
SiO_2	0.01 - 100 %	
TiO_2	0.01 - 100 %	
LOI 1000°C	0.01 - 100 %	
Options:	Code 4F - Sulphate (SO_4 - 0.3% by Infrared)	$23.65
	Code 4F - Carbonate (CO_2 - 0.01% by IR or Coulometry)	$19.80

Ores, Concentrates, and Commodities

Iron Ore

Davis Tube Recovery - Recoveries of ferromagnetic products are evaluated by Grind Size and Magnetic Field Strength (Gauss). To determine the chemical composition, the magnetic and non-magnetic recoveries can be analyzed using a Lithium Metaborate fused disc and analysis by XRF. Contact Actlabs to discuss your requirements as procedures are very ore-specific.

Code 8: Iron Ore (XRF) **Price: $34.20**			
Oxides	**Detection Limits (%)**	**Oxides**	**Detection Limits (%)**
SiO_2	0.01	CaO	0.01
TiO_2	0.01	Na_2O	0.01
Al_2O_3	0.01	K_2O	0.01
Fe_2O_3	0.01	P_2O_5	0.01
V_2O_5	0.003	Cr_2O_3	0.01
MnO	0.005	LOI	0.01
MgO	0.01		

Add-ons	Price	Add-ons	Price	Add-ons	Price
Davis tube magnetic separation	$81.00	Satmagan Test	$19.45	FeO by titration	$18.45
		Metallic Fe by titration	$103.50	TGA Analysis	$238.50
		Total Fe by titration	$103.50		

Lithium Ore

Code 8: Lithium Ore	
Lithium Ore	**Price**
Li assays by Peroxide Fusion ICP-OES (detection limit 0.01%)	$17.55
Li assays by 4-Acid Digestion ICP-OES (detection limit 0.01%)	$14.40
Li assays on brines by ICP-OES (detection limit 0.05 mg/L)	$17.10
Any of the above packages can be converted to multielement analysis. Common elements requested are B, Ca, K, Mg.	$19.45

Notes: For geochemical packages, see Code 1F2 for 4-Acid Digestion ICP or Code Ultratrace 7 for Peroxide Fusion ICP-OES+ICP-MS. Code 6MB for Multielement brine package.

Manganese Ore

Code 8 - Manganese Ore: - Li borate fusion/XRF **Price: $34.20**			
Elements	**Detection limits**	**Elements**	**Detection limits**
Mn	0.01 - 80%	MgO	0.01 - 100 %
Al_2O_3	0.01 - 100 %	Na_2O	0.01 - 100 %
BaO	0.01 - 100 %	P_2O_5	0.002 - 100 %
CaO	0.01 - 100 %	SiO_2	0.01 - 100 %
Cr_2O_3	0.005 - 100 %	TiO_2	0.01 - 100 %
Cu	0.005 - 5 %	V_2O_5	0.005 - 100 %
Fe_2O_3	0.01 - 100 %	LOI 1000°C	0.01 - 100 %
K_2O	0.01 - 100 %		

Nickel Laterite

Code 8 - Ni Laterite **Price: $34.20**			
Elements	**Detection limits**	**Elements**	**Detection limits**
Al_2O_3	0.01%	MnO	0.005%
CaO	0.01%	Na_2O	0.01%
Cr_2O_3	0.01%	NiO	0.03%
Co_3O_4	0.005%	P_2O_5	0.01%
CuO	0.005%	SiO_2	0.01%
Fe_2O_3	0.01%	TiO_2	0.01%
K_2O	0.01%	V_2O_5	0.003%
MgO	0.01%	LOI 1000°C	0.01%

Oil Shale

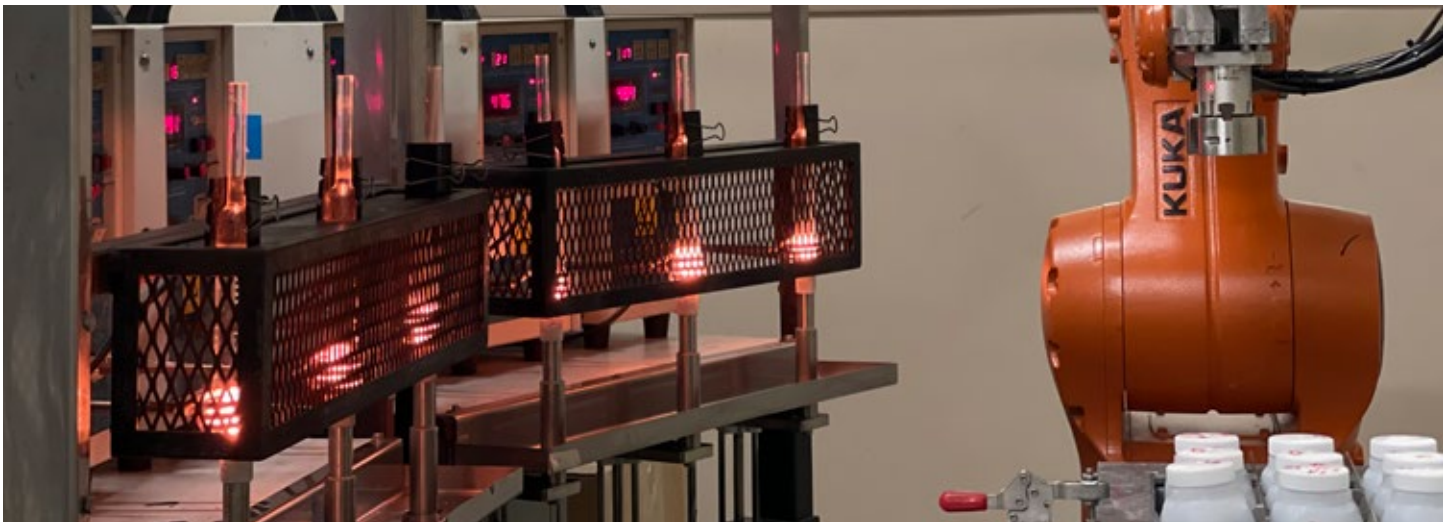
These analytical methods are used in exploration programs to determine the anticipated shale oil yield and to better delineate core characteristics.

Code 8 - Oil Shale		
Analytical Method	Description	Price/ sample
Sample Preparation	Wash, grind, homogenize 40 mesh	$10.90
	Grinding for Fischer Assay	$26.95
Rock-Eval 2 Pyrolysis	S1 - hydrocarbons evolved at 300°C (mg/g)	$193.95
	S2 - hydrocarbons evolved between 300 and 600°C (mg/g) heating at 25°C/min	
	S3 - organic carbon dioxide evolved at 300°C and up to 390°C (mg/g)	
	Production Index, Hydrogen Index, Oxygen Index and TMAX (MUST ANALYZE TOC TO OBTAIN HI AND OI)	
	Total Organic Carbon (LECO)	
Rock-Eval 6 Pyrolysis	Programmed pyrolysis + TOC + CO_2	$281.85
Fischer Assay-ASTM D3904	Free water - moisture (wt%) by oven drying	$214.30
	Retort water (wt% and L/tonne)	
	Oil yield (wt% and L/tonne)	
	Gas yield (wt% and L/tonne)	
	Spent shale (wt%)	
	Gas average molecular weight	
	Oil relative density	
Elemental Analysis	Total carbon, sulphur	$24.80
	Total organic carbon	$53.65
	Total oxygen	$90.00
	Pyritic Sulphur	$64.50
	Sulphate Sulphur	$43.00
	Mercury	$149.55
	Fluoride	$64.50
	Mineral Identification	$203.65
Whole Rock Analysis	A whole rock analysis is performed to provide chemical analysis of inorganic components of the rock	$48.40
Trace Metal Analysis	Near total digestion is performed and a full trace metal scan by ICP shall be conducted to include at least the following elements: Cu, Pb, Zn, Fe, W, Mo, Sn, In, Bi, Cd, Sb, F, Nb, Ta, Th, Cs, Y, As, Ag, U and V.	$37.80

Potash

Includes moisture, insoluble residue left from the water soluble component and the ICP-MS, ICP-OES soluble multielement suite.

Code 8: Potash (ppm) Price: $80.35			
Elements	Detection Limt (ppm)	Elements	Detection Limt (ppm)
Al_2O_3	0.01%	La	1
CaO	0.01%	Li	1
Fe_2O_3	0.01%	Mo	1
K_2O	0.01%	Nb	1
MgO	0.01%	Nd	1
MnO	0.01%	Ni	1
Na_2O	0.01%	Pb	1
P_2O_5	0.01%	Pr	1
TiO_2	0.01%	S	10
Ag	0.2	Sc	1
Ba	1	Sm	1
Be	0.2	Sn	1
Cd	1	Sr	1
Ce	1	Ta	1
Co	1	Tb	1
Cr	1	Th	1
Cu	1	U	2
Dy	0.2	V	1
Er	0.2	W	1
Eu	0.2	Y	1
Ga	1	Yb	0.1
Gd	1	Zr	1
Hf	1	Zn	1
Ho	1		



Rare Earth Elements

Code 8 - REE Assay: Rare Earth Element-Niobium-Zirconium-Yttrium-Tantalum-Uranium-Thorium-Beryllium-Phosphate-Tin Assay ICP-OES and ICP-MS Package

Rare earths and rare elements are among the most difficult to analyze properly. It is essential that the sample be ground to 95%-200 mesh to ensure complete fusion of resistate minerals. The analysis requires a lithium metaborate/tetraborate fusion with subsequent analysis by ICP-OES and ICP-MS. Mass balance is required as an additional quality control technique and elemental totals of the oxides should be between 98 to 101%. In certain circumstances the presence of small amounts of phosphate will have very severe consequences to Nb_2O_5 assays by this method with results being very low for Nb_2O_5. Reanalysis is required for Nb_2O_5 by fusion XRF. In many cases these types of deposits may contain high amounts of fluorite. This should be noted on the Request for Analysis form or F assays should be requested. This will speed up processing as mass balance won't be achieved otherwise and a delay in returning results will ensue as samples get repeated.

IN NO CIRCUMSTANCES SHOULD AN ACID DIGESTION OF ANY TYPE BE USED TO EVALUATE THE ELEMENTS BELOW AS THEY WILL ONLY BE PARTIAL ANALYSIS.

All elements are quantified and no exceeding upper limit signs are reported.

Fusion ICP-OES & ICP-MS, Elements and Detection Limits (ppm, except where noted)			$73.80
Elements	**Detection Limits**	**Elements**	**Detection Limits**
Al_2O_3	0.01%	Rb	2
CaO	0.01%	Sb	0.5
Fe_2O_3	0.01%	Sc	1
K_2O	0.01%	Sn	1
MgO	0.01%	Sr	2
MnO	0.005%	Ta	0.1
Na_2O	0.01%	Th	0.1
P_2O_5	0.01%	Tl	0.1
SiO_2	0.01%	U	0.1
TiO_2	0.001%	V	5
LOI	0.01%	W	1
Ag	0.5	Y	2
As	5	Zn	30
Ba	3	Zr	4
Be	1	La	0.1
Bi	0.4	Ce	0.1
Co	1	Pr	0.05
Cr	20	Nd	0.1
Cs	0.5	Sm	0.1
Cu	10	Eu	0.05
Ga	1	Gd	0.1
Ge	1	Tb	0.1
Hf	0.2	Dy	0.1
In	0.2	Ho	0.1
Mo	2	Er	0.1
Nb	1	Tm	0.05
Ni	20	Yb	0.1
Pb	5	Lu	0.04

If samples contain >0.3% P_2O_5 then Nb_2O_5 and ZrO_2 is recommended to be replaced by fusion XRF as ICP-MS results may be very low.

Add-ons:
Code 8 - XRF Nb_2O_5, ZrO_2 and Ta_2O_5 (0.003%) $21.60
Code 4F - F (0.01%) by ISE $24.55

Note: Chalcophile elements are semi-quantitative. An additional fee will be incurred if assays are required to quantify chalcohpile elements

Uranium

Code 8 - Uranium: Total uranium can be determined by delayed neutron counting using an automated system at a nuclear reactor. The principle advantage of this is to provide very rapid and accurate assays for high volumes of samples at a very low cost. The upper limit of this technique is 1% U. Results can be reported as U or U3O8. From 1 to 10% U3O8 fusion XRF will provide the best quality assay results and above 10% U3O8 titration is recommended for accuracy.

Acid digestion using both aqua regia "partial" and 4-acid "near total" digestion with ICP-MS is also possible but uranium in resistate phases (zircon, monazite, etc) may not be included in the assays. "Near Total" digestions may not be total for uranium depending on mineralogy. Hydroflouric acid is used in the digestion and some uranium may be volatilized due to combination with the HF.

Code 8 - Uranium	Price
Code 5D - U_3O_8 Assay DNC (0.1 ppm - 1% U3O8)	$17.25
Code 8 - U_3O_8 Aqua Regia "Partial" Digestion by ICP-MS	$18.45
Code 8 - U3O8 Assay by XRF (0.005%- 10% U3O8)	$26.00
Code 8 - U_3O8 4-Acid "Near Total" by ICP-MS	$20.30
Code 8 - U_3O_8 Titration (>10% U_3O_8)	$38.75
Geochem V, U by XRF Pressed Pellet	$13.00
Code 5D-Peroxide Boron (2 ppm)	$19.40

Radionuclides

Naturally-Occurring Radioactive Materials (NORM) consist of radioactive material that comes out of the earth's crust and mantle. Human activity results in increased radiological exposure. Industries, excluding uranium mining and all associated fuel cycle activities, are known to have NORM issues, include coal mining and combustion, oil and gas production, metal mining and smelting, mineral (rare earth, titanium and zirconium), fertilizer (phosphate), building and recycling.

Actlabs provides NORM radiological testing to determine whether materials meet the safe limits for handling, disposal and transportation. The following radionuclides are usually regulated under the NORM guidelines: **Uranium^{238} Series**, **Thorium^{230}**, **Radium^{226}**, **Lead^{210}**, **Thorium^{232}**, **Radium^{228}**, **Thorium^{228}** and **Potassium^{40}**.

Solids and waters are analyzed using a Gamma Spectroscopy method for the NORM radioactive elements.

Code 14 - Radiochemical Test Packages

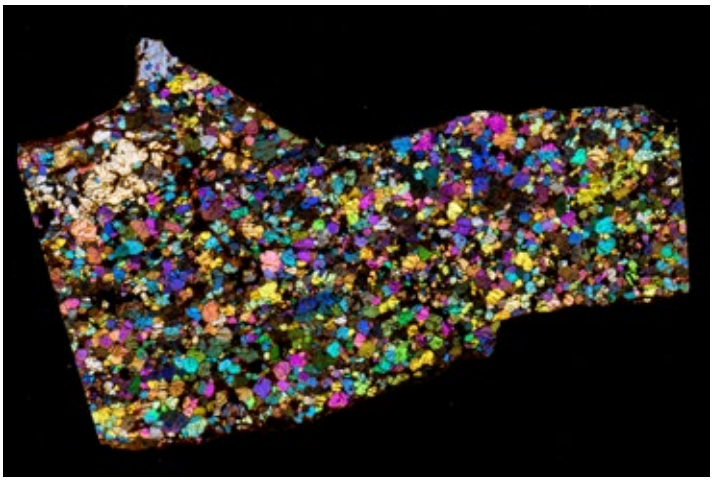
The following radiochemical tests are offered for both geological (solid, water, vegetation, sediment, soil and rock) and environmental materials.

Nuclide	Method	Water - Detection Limit	Solid - Detection Limit	Price - Water	Price - Solid
Ra226	Alpha Spectrometry	0.005 Bq/L	0.01 Bq/g	$193.70	$224.90
Gross α, Gross β	L/B Alpha, Beta Counting	α = 0.05 Bq/L; β = 0.15 Bq/L	α = 0.05 Bq/g; β = 0.15 Bq/g	$128.50	$128.50
Pb210	L/B Alpha, Beta Counting	0.01 Bq/L	0.1 Bq/g	$214.50	$246.65
Po210	Alpha Spectrometry	0.01 Bq/L	0.01 Bq/g	$188.05	$220.20
Th230 and Th232	Alpha Spectrometry	0.01 Bq/L	0.01 Bq/g	$214.50	$246.65
Ra228	Beta Counting	0.01 Bq/L	0.04 Bq/g	$214.50	$246.65

Code 15 - Gamma Scan
Method: Gamma Spectrometry

Nuclide	Detection Limt
Pb210	0.1 Bq/g
Ra226	0.1 Bq/g
Pb212	0.05 Bq/g
Pb214	0.1 Bq/g
Tl208	0.03 Bq/g
Bi212	0.05 Bq/g
Bi214	0.1 Bq/g
Ac228	0.1 Bq/g
K40	1.0 Bq/g
Price:	$107.75

Applied Mineralogy and Metallurgy



MLA & QEMSCAN Services

Applied Mineralogy is a discipline of mineralogy by which the unknowns and problems encountered during different mining steps can be approached and solved. Applied Mineralogy can be used to characterize the ore body, identify and quantify target minerals and their associations, and reveal the liberation, locking and grain size of the favoured phases; The data provided by Applied Mineralogy is essential for ore characterization, optimizing recovery and mineral processing plans.

Geometallurgy is an integrated methodology and multi-disciplinary field which aims to add value to a mineral deposit or resource while looking ahead at risk- reduction, improved decision-making and cost-effective down-stream activities (e.g. development, pre-feasibility, feasibility and production). The objective of successful Geometallurgy is quality ore- characterization and establishing links and relationships between geology, mineralogy and processing characteristics.

For quantitative mineralogical analyses, Actlabs is equipped with FEI Quanta 650F MLA and QEMSCAN 650F instruments; they are state-of the-art Scanning Electron Microscopes (SEM) with superior resolution and performance over typical SEM systems. The Field Emission Gun source makes for significantly higher resolution analysis relative to regular MLA and QEMSCAN technology. Actlabs' Quanta 650F MLA and QEMSCAN 650F provide rapid, automated, non-destructive quantitative micro analysis used for integrated mineralogical and petrographical analyses.

Actlabs offers mineralogical analysis of assay rejects, drill core, RC drilling chips, plant samples and most other forms of man-made and natural materials. MLA can be applied to precious metals (Au, Pt, Pd, Ag), base metals (Cu, Ni, Co, Pb, Mo, Zn), ferrous and non-ferrous raw materials (Fe, Sn, Mn, W, Ta, Nb, U and REE), mineral sands, and graphite bearing rock.

Deliverable services for Geometallurgy and Applied Mineralogy

Quantified Modal Mineralogy Analysis
A rapid and efficient solution for identifying and quantifying the minerals present with detection limit of 0.1%. The measurement can be done on both thin section and polished section.

Particle and Grain Data Analysis
This type of analysis provides information on texture variations, size distribution of the target minerals, as well as locking and liberation characteristics for the ore minerals. Theoretical grade/recovery curve and association of the ore mineral with the gangue is also provided by this analysis.

Specific Phase Search (Including specific packages for Gold and Silver minerals)
This type of analysis is suitable to find PGM, low-grade levels of ore minerals, and other low-grade minerals like gold and silver. Trace and pathfinder phases can also be characterized. Once trace phases have been identified, data such as grain size distribution, classified images and particle counts can be provided. Actlabs has extensive experience in mineralogical analyses of precious metals as well as the ore minerals. Using our FEG (Field Emission Guns) equipped QEMSCAN/MLA we are able to find and characterize fine micron-sized or sub-micron sized (>0.3 µm) Gold or Silver particles locked in the pyrites, quartz and other gangue minerals. We can perform total precious metal deportment using FEG.

SE/BSE Imaging & Spectrum
Field Emission Gun technology enables us to take high-quality Backscattered Electron (for textural) and Secondary Electron (for topo-graphic) images. In addition, both our MLA and QEMSCAN are equipped with two BRUKER SSD EDS detectors. The combination of detectors with the high intensity bright FEG source provides rapid and therefore low-cost analysis for the customer.

Electron Probe Micro-analyzer
Whenever the major and minor elements of a mineral shall be identified and quantified with a high precision, EPMA in-situ analyses will be the solution. Actlabs has a procedure for oxides, silicates, sulphides and sulphates as well as alloys. EPMA analysis can be done in conjunction with MLA and QEMSCAN measurements as a complementary method.

Petrographic Analysis
For detailed description the rock, its mineralogy and textural relationships, as well as identification of the Coal components, Actlabs employs transmitted/reflected petrographic microscopy (Olympus BX52) on polished thin sections and polished sections.

For more details and quotation inquiries, please contact geometallurgy@actlabs.com.

Applied Mineralogy and Metallurgy

X-Ray Diffraction

Most minerals are crystalline and therefore scatter X-rays in a regular, characteristic way dependent on their crystal structure. Each mineral produces a unique diffraction pattern and can be identified from that pattern like a fingerprint. Identification of minerals is made by comparing their diffraction patterns with a library of over 17,000 mineral patterns stored in the International Centre for Diffraction Data (ICDD). Detection limits depend on the sample. For geological material, it is estimated that the minerals present in less than 2% of the sample might not be detected. The samples for X-ray diffraction analysis are ground or milled to a fine powder and then hand pressed into the sample holder. Approximately 1cm^3 of the material is sufficient for rock mineral analysis but smaller amounts can also be accommodated by using a low background holder.

Code 9	Price
Mineral Identification (semi-quantitative) - minerals are identified and their amounts determined using the Rietveld method	$113.40
Mineral Identification (quantitative) - minerals are identified and their amounts determined using the Rietveld method Corundum is added to the sample as an internal standard in order to determine the amount of X-ray amorphous material	$170.10
Mineral Identification (qualitative) - minerals are identified, however their amounts are not determined	$85.05
Clay Speciation	$217.35
Mineral Identification (Rietveld) + Clay Speciation	$321.55

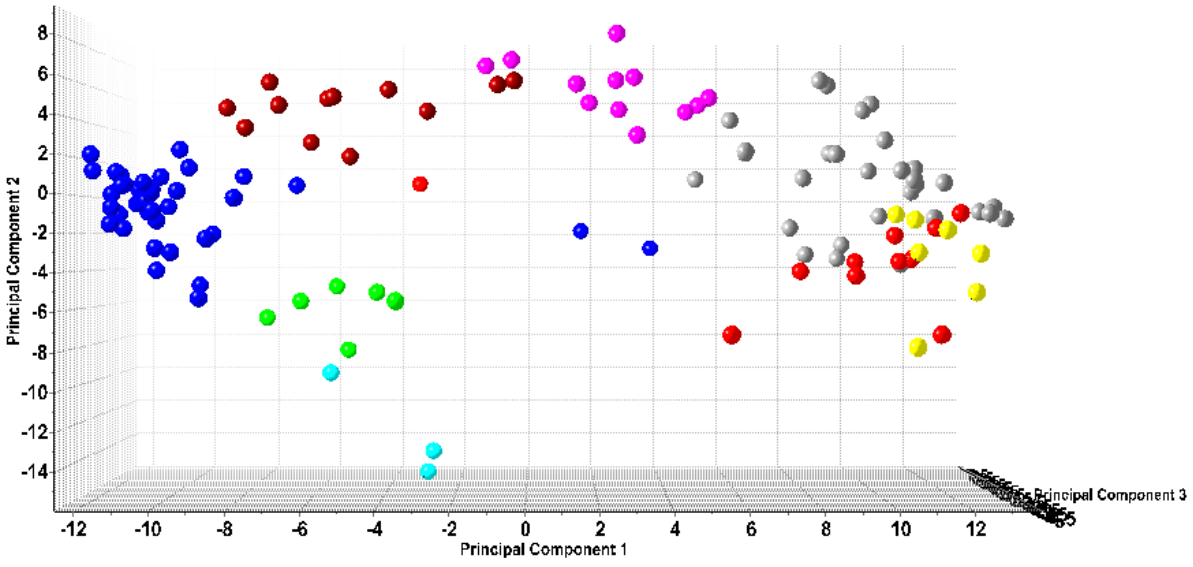
XRD Cluster Analysis

This is a statistical tool that groups XRD patterns into clusters based on the similarity of their peak and profile information, and it can be used to rapidly group large data sets into smaller clusters with more similar mineralogy. This has potential applications for mining and exploration, wherein clustering would highlight existing changes in mineralogy within a deposit. Clustering would also be useful for determining mineralogical variability within metallurgical processing samples that could inform methodology.

Some Useful Applications:

- Create a multidimensional compositional ore deposit maps or alteration maps
- Ore grade control

Pricing available upon request.



Applied Mineralogy and Metallurgy

Laser Ablation ICPMS

Actlabs offers Laser Ablation ICPMS services for U-Pb dating and In-Situ Trace Elements analysis; the laser beam can analyze spots from 5 microns to 100 microns. It is recommended to use round polished sections or polished thick sections. A number of elements can be scanned at the same time. Some applications include: Analysis of trace elements in carbonate-rich matrices such as mussel shells, otholites, etc. and Rare earth elements scan in minerals.

Electron Microprobe Analysis

The electron microprobe is used to determine the major and minor elements compositions of minerals in polished sections. It is an in-situ microbeam instrument, like the SEM, but wavelength spectrometers (WDS) are used to detect the X-ray counts from the sample surface instead of the EDS. Unlike the EDS, which detects and counts the X-rays signals for all elements at the same time, the WDS counts X-rays signals for only one element at a time. The WDS can count many more X-rays for the specific element in the same length of time and hence is more accurate than EDS, and has a lower detection limit. The relative error for microprobe is +/- 1% with detection limit of around 100 .

All pricing is by request. Please contact **geometallurgy@actlabs.com**

Metallurgical Services

Actlabs offers a full characterization of the ore and evaluation and testing of ore processing and extraction methods. We use geometallurgy techniques to characterize the ore and forecast the behavior of the ore and gangue minerals during processing and optimize the recovery.

We offer bench-scale metallurgical testing which is customized and designed in consultation with each client and project. Services offered cover a wide range of precious metals, base metals and industrial minerals. dditional Services may become available on site and additional services including pilot plant tests are available through a partner service provider, please enquire.

Metallurgical services offered include:		Price
Code S6	Separating -2 micron material	On Request
Code S7mi	Methylene iodide heavy mineral separation specific gravity can be customized (100 grams)	On Request
Code S7w	Sodium polytungstate heavy mineral separation specific gravity can be customized (100 grams)	On Request
Sample Preparation	Custom preparation of small to bulk samples including compositing, blending and preparation of representative test sub-samples Customized crush and grind size	
Comminution	Crushing (Jaw & Roll) Grinding (Steel Ball & Rod, Ceramic Media) Bond Work Index Size Classification (Screening and Cyclosizing)	
Gravity Concentration	Centrifugal Concentration (Knelson) Shaking Table (Wilfley) Heavy Liquid Separation	
Flotation	Batch Flotation Kinetic Testing Locked Cycle Testing	
Hydrometallurgy	Bottle roll and tank leaching Cyanide, acid and alkaline leach CIL & CIP Activated Carbon Testing (Adsorption & Quality) Sequential Diagnostic Leaching	

All other pricing by request, contact metallurgy@actlabs.com

Isotopic Analysis & Geochronology

Isotopic Analysis

When submitting samples, please supply details on rock or mineral type and alteration.

Isotopic Analysis			
Code 10 A - Parameter	**Amt. Required**	**Precision**	**Price**
Pb - Isotopic analysis by HR-ICP-MS (Pb >15ppm) (1-10 samples)	~ 1 g	0.4 - 0.5%	$225.15
Pb - Isotopic analysis by HR-ICP-MS (Pb >15ppm) (>10 samples)	~ 1 g	0.4 - 0.5%	$166.30
Pb - Isotopic analysis	~ 1 g	0.1 - 0.2%	On request
Nd - Isotopic Analysis	~ 1 g		On request
Sr - Isotopic Analysis	~ 1 g		On request
Sm-Nd - Isotopic Analysis	~ 1 g		On request
Rb-Sr - Isotopic Analysis	~ 1 g		On request
Hg - Isotopic Analysis	~ 1 g		On request
$\delta^{13}C$ – Graphite or Organic Material	1 mg C	0.2 ‰	$179.35
$\delta^{13}C$ and $\delta^{18}O$ – Carbonates	1 mg C	0.2 ‰	$124.00
$\delta^{13}C$ and $\delta^{18}O$ – Siderite, Magnesite, Dolomite	1 mg C	0.2 ‰	$179.35
Nitrogen Isotopes - Organic Material			$166.30
Deuterium Isotopic Analysis – Water	20 ml	3.0 %	$198.45
Deuterium Isotopic Analysis – Minerals	1 mg	0.2 ‰	$455.70
$\delta^{18}O$ – Water	20 mL	0.2 ‰	$133.95
$\delta^{18}O$ – Silicates	15 mg	0.3 ‰	$297.70
$\delta^{18}O$ – Sulphates	25 mg	0.3 ‰	$168.70
$\delta^{18}O$ – Organics	10 mg N	0.2 ‰	$173.65
$\delta^{34}S$ – Sulphate	10 mg	0.2 ‰	$114.10
$\delta^{34}S$ – Sulphate in water			$178.60
$\delta^{34}S$ – Sulphide	5 mg	0.2 ‰	$114.10
$\delta^{34}S$ – Sulphide-bearing material which contains carbonate	100 mg	0.2 ‰	$158.75
δ^{34} – Silicate rocks which contain sulphur			$158.75
^{3}H – Direct	20 mL	8.0 TU	$171.75
^{3}H – Enriched	1L	0.8 TU	$460.45
^{3}H – Accelerator Mass Spectrometry (AMS)	1L		$750.10
C-14 - Accelerator Mass Spectrometry (AMS)	please inquire		$643.05

Geochronology

The dating strategy depends on the type of formation (magmatic, metamorphic or sedimentary), the sample composition and the age of the formation. The concentration of the mother and the daughter isotopes, as well as the apparent age can be determined with high precision. In many cases, however, the determined age may not be the real age of the geological event. The apparent age may be affected by the post-depositional or post-formation history of the rocks. Natural contamination of chemical sediments with detrital material can also affect the results of dating of diagenesis.

There are some techniques and calculations which can "look through" the post formation event. These include isochron dating (K-Ar, U-Pb, Rb-Sr and Sm-Nd) or the step heating Ar-Ar technique of the K-Ar method. In the Ar-Ar technique, the K and Ar are measured on the same sample aliquot. First the sample is irradiated in a nuclear reactor, where fast neutrons convert some of the 39K to 39Ar. After irradiation, the Ar is released fractionally by incremental heating. The result is a series of apparent ages from which useful information about the geologic history and the age of the sample can be inferred. Specific techniques for dating clay fractions have also been developed.

Our geochronological services provide dating methods for all types of geological samples through use of modern analytical facilities.

For the dating of a monomineralic sample only tens of milligrams of sample are required. For rocks, a few hundred milligrams are typically used for analysis. Size of the rock sample required will vary considerably for mineral separation depending on which minerals must be separated and the amount and type of the accessory minerals present.

CODE 10B - Ages of geological formations or secondary events (i.e. alteration or metamorphism) can be determined through using K-Ar, (Ar-Ar), U-Pb, Rb-Sr or the Sm-Nd dating methods. These analytical procedures include several steps:

(i) dating method selection

(ii) sample collection

(iii) sample preparation, mineral separation and treatment

(iv) irradiation of the samples in a nuclear reactor for the Ar-Ar technique

(v) high precision determination of the concentration of the mother and daughter isotopes by TIMS (thermal ionization mass spectrometry)

(vi) apparent age calculation and interpretation of the results

Geochronology	
10 B - Services Offered	**Description (All prices by request)**
K-Ar dating	Rock fractions, clay fractions and separated minerals (e.g., biotite, hornblende, sericite, K-feldspar, illite, glauconite, etc.)
K-Ar dating in duplicate	Two independent measurements on one sample
^{40}Ar-^{39}Ar step heating dating	Rock fractions, clay fractions or separated minerals (e.g., biotite, hornblende, sericite, K-feldspar, illite, glauconite, etc.)
U-Pb dating by Laser Ablation	Single grain analysis (e.g., zircon, monazite, titanite, apatite)
Rb-Sr dating by TIMS	Isochron dating whole rock and minerals
Sm-Nd dating by TIMS	Isochron dating whole rock and minerals
Re-Os dating	Re-Os dating
Petrographic description	Includes thin section preparation
Mineral Separation	Specific mineral phases are separated to provide best data for age dating

Discounts may be applicable for large dating programs.
Contact geochronology@actlabs.com for more information

Mine Site Services

Mine Site Laboratories allow you to receive a range of Actlabs services on site at your exploration or mining facility. Our mine site laboratory services are custom designed to suit the requirements of your project.

Custom Mobile Sample Laboratories
For those projects that have logistical barriers or it's more economical to process samples on-site, Actlabs Mobile Sample Laboratories is your solution. Actlabs can provide and deliver a complete turnkey package to operate an on-site preparation or complete laboratory anywhere in the world. The construction and operation of remote sample testing facilities requires very robust choice of equipment to ensure reliability and to minimize downtime. These labs, with state-of-the art equipment and supplies, can be configured and supplied very quickly as Actlabs maintains a stock of new equipment for custom mobile labs

Some equipment which may be employed in mobile sample labs include:

- Jaw crushers
- Pulverizers
- Splitters (Riffle or Rotary)
- Dust collectors
- Drying ovens
- Core saws

In order to recommend the best solution for your project, we require the following information:

- Type of Analysis Required
- Size and Type of Sample
- Number of samples to be processed per day (maximum and minimum)
- How long the program will operate

Our experienced Mobile Laboratory Team can provide Standard or a customized solution based on your project requirements and is 'Fit for Purpose'. Contact our Client Service Team to discuss your project needs and how Actlabs Custom Mobile Laboratories is the right fit for you; mobilelabs@actlabs.com.

Mine Site Laboratory Services

Mine site laboratories allow you to receive a range of Actlabs services on site at your mining facility. Our mine site laboratory services are fit for propose and designed to suit the requirements of your project.

At Actlabs we:

- Design and build new mine site labs for sample preparation and/or analytical services
- Optimize existing mine site labs
- Expand mobile sample preparation facilities into full-service labs.
- Operate and maintain mine site labs
- Perform Laboratory audits
- Offer training and consulting

Terms and Conditions

Fees and Payment

a) All prices in this pricelist are in US dollars and are applicable for samples received in Canada from clients with billing addresses outside of Canada.

b) These prices apply to most geological materials for routine analyses. A surcharge may apply for abnormal matrices or non-routine analytical requirements. The client will be advised of any such conditions prior to performing the analytical work.

c) A minimum charge of $100.00 will be effective on all orders. A fee of $75.00 will be charged if a Chain of Custody form is required.

d) Payment should accompany the order unless credit has been established. Terms are net 30 days.

e) Prices and packages are subject to change without notice.

f) Customers are responsible for paying bank charges and should not be deducted from the total amount of the invoice.

g) Please select OUR under Details of Charges when paying by direct bank deposit (EFT).

h) Clients can pay invoices by cheque, bank draft, Visa, Mastercard, AMEX or direct bank deposit (EFT). To pay by credit card, a signature is required - either in the original paperwork or sent by fax or e-mail. We also require the security code found on the card. If paying by Western Union please add a surcharge of 10% to your payment.

i) Any customs or shipping charges incurred while shipping samples to Actlabs is the responsibility of the customer, unless specified otherwise.

Liability

a) Any analysis, testing, inspection or investigation in connection with any work performed by Activation Laboratories Ltd. shall be conducted in accordance with recognized professional analytical standards. Neither Activation Laboratories Ltd., nor its subcontractors, consultants, agents, officers or employees shall be held responsible for any loss or damage resulting directly or indirectly from any default, negligence, error or omission. While every effort will be taken to store the unused portion of your samples, Activation Laboratories Ltd. cannot bear any responsibility for loss or damage, regardless of the cause.

b) The liability, if any, of Activation Laboratories Ltd. shall be limited to the cost of performing the analyses.

c) Governing law shall be in the Province of Ontario, Canada.

Services

a) We reserve the right to subcontract work to affiliated laboratories.

b) It is the responsibility of the client to determine the suitability of any services provided by Activation Laboratories Ltd.

Confidentiality

a) All data derived on client's samples is confidential only to the client and cannot be disclosed to other parties unless approved in writing by the client. In the event of demands by regulatory bodies data may be released to them if subpoenaed.

For direct bank deposit, pay to the account of Activation Laboratories Ltd.

Royal Bank of Canada
59 Wilson Street West
Ancaster, Ontario CANADA L9G 1N1
Tel: (905) 648-4411

Transit # 00102
Institution # 003
Swift: Royccat2
Account # 400 389 3

Appendix

Useful Information

Geochemistry vs. Assays

Geochemistry analysis provides an expected precision of +/- 20% at ≥100x the detection limit. This type of analysis is for trace levels of metals and base metals generally less than 1%.

Assays analyses are for ore reserve calculations and can measure higher levels of metals and with increased precision of +/- 2-3% at greater than 100x the detection limit. For major elements the precision is expected to be +/- 1-2% at greater than 100x the detection limit.

Chemical Conversions

Element	Compound	Factor
Al	Al_2O_3	1.889
Ba	$BaSO_4$	1.699
Ca	CaO	1.399
CaO	$CaCO_3$	1.785
CaO	$CaSO_4$	3.397
Ca	CaF_2	1.948
CaO	CaF_2	1.392
Cr	Cr_2O_3	1.462
Fe	FeO	1.286
FeO	Fe_2O_3	1.111
Fe	Fe_2O_3	1.43
K	K_2O	1.205
Mg	MgO	1.658
Mn	MnO	1.291
Mo	MoS_2	1.668
Na	Na_2O	1.348
P	P_2O_5	2.291
S	SO_4	2.996
Sr	$SrSO_4$	2.096
Th	ThO_2	1.138
Ti	TiO_2	1.668
U	U_3O_8	1.179
W	WO_3	1.261
V	V_2O_5	1.785
Zr	ZrO_2	1.35

Common Tyler Sieve Sizes

Mesh	Aperature (µm)
10	2,000
20	841
35	500
60	250
80	177
100	149
150	105
170	88
200	74
250	63
270	53
325	44
400	37

Common Drill Core Sizes

Element	Compound	Factor
AQ	27.0	0.57
TT	35.0	0.96
BQ	36.4	1.04
NQ	47.6	1.78
HQ	63.5	3.17
BQ3	33.5	0.88
NQ3	45.1	1.6
HQ3	61.1	2.98

Core weight per metre (kg) =
core volume per metre x specific gravity

Gold Conversion Factors

1 ppb	0.001 g/tonne
1 ppm	1 g/tonne
1 oz/ton	34.286 grams/tonne
1 gram/tonne	0.0292 oz/ton
1 gram/m3	0.0421oz/yd3

Grain Size (Diameter)

Gravel	2 to 4 mm
Sand	63 µm - 2 mm
Silt	4-63 µm
Clay	<4 µm

Pulverization Contaminants Added

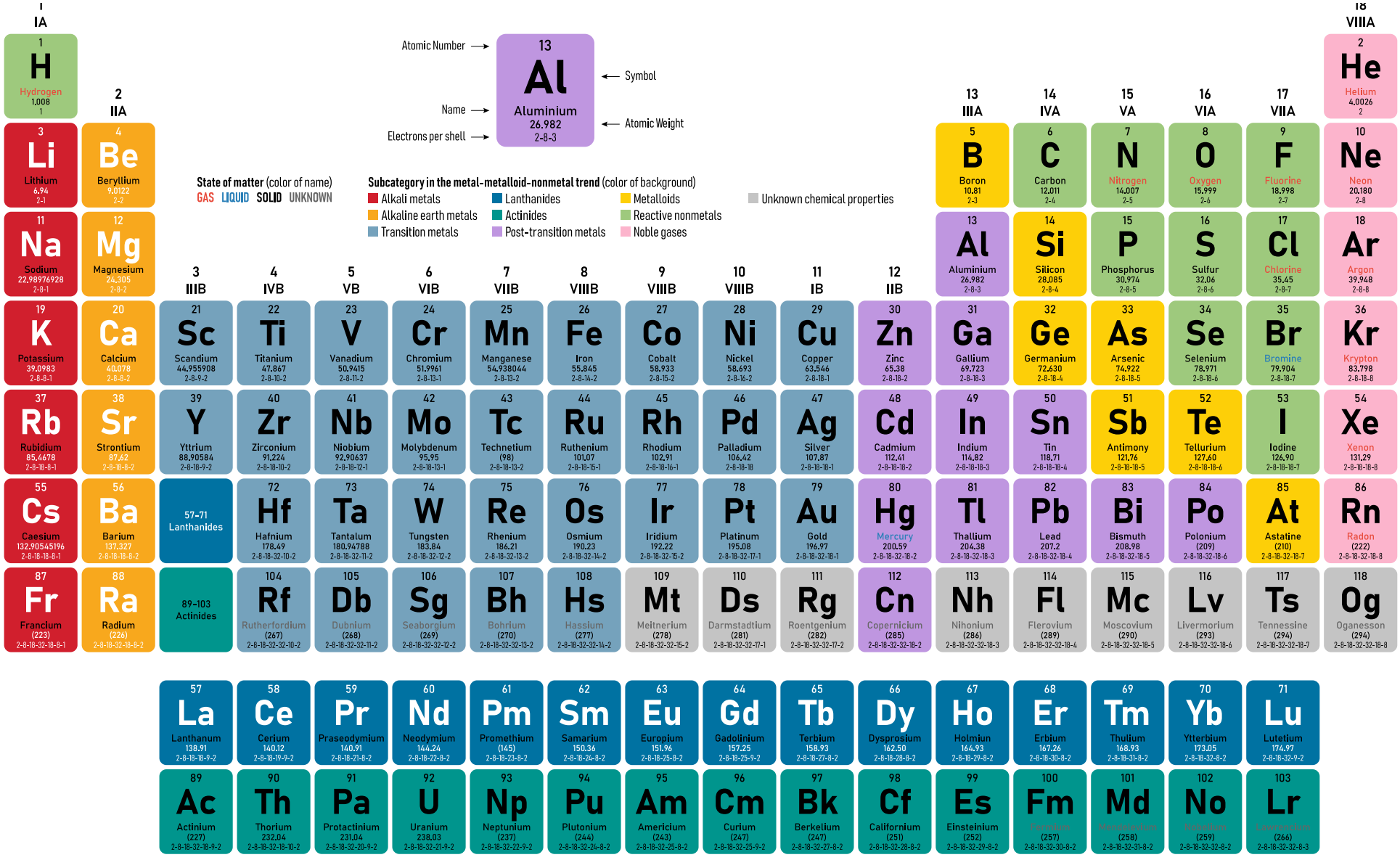
Mill Type	Contaminant Added
Mild Steel (best choice)	Fe (up to 0.2%)
Hardened Steel	Fe (up to 0.2%), Cr (up to 200 ppm), trace Ni, Si, Mn and C
Ceramic	Al (up to 0.2%), Ba, trace REE
Tungsten Carbide	W (up to 0.1%), Co, C, Ta, Nb and Ti
Agate	Si (up to 0.3%), Al, Na, Fe, K, Ca, Mg, Pb

(amount added depends on hardness of material and particle size required)

Ore Content

1% Cu	2.89% $CuFeS_2$ (chalcopyrite)
1% Mo	1.67% MoS_2 (molybdenite)
1% Pb	1.15% PbS (galena)
1% U	1.18% U_3O_8 (pitchblende)
1% W	1.26% WO_3 (scheelite)
1% Zn	1.49% ZnS (sphalerite)
1% Fe	2.15% FeS_2 (pyrite)
1% Fe	1.57% FeS (pyrrhotite)
1% Fe	1.38% Fe_3O_4 (magnetite)
0.1% U_3O_8	2 lbs/ton U_3O_8

PERIODIC TABLE OF THE ELEMENTS



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* For information on which test methods are accredited, please refer to the Actlabs or SCC website