Hazen Research, Inc.
4601 Indiana Street
Golden, CO 80403 USA
Tel: (303) 279-4501
FAX: (303) 278-1528

ANALYTICAL LABORATORY SERVICES
FEE SCHEDULE

Effective March 1, 2023

Fuel and Biomass
Metals
Mineralogy
Precious Metals Recovery
Radiochemistry
Waters

www.hazenresearch.com

Serving the Mineral and Chemical Industries Since 1961

CONTENTS

CONTENTS

GENERAL INFORMATION

SUBMISSION FORMS

To order analyses at Hazen Research, Inc. please complete our Analytical Request Form (ARF). Use the Chain of Chain of Custody (COC) Form for radiochemical analysis. The forms can be downloaded from our website. Required sample quantities can be found on page 8. A delay in processing may result if samples arrive without a signed ARF or COC.

Please fill out the ARF completely. We strongly encourage you to provide, if known, requested reporting units, information about estimated values, and matrix or analytical method on the checklist page of the ARF. If you have a previous analytical report and are requesting similar analysis, please include the Lab Control ID.

Samples arriving at Hazen after **2:00 p.m.** will be logged into our system on the next business day. Hazen reserves the right to refuse to receive or analyze samples that are deemed unsafe to handle in our facilities, or for any other reason. Samples without an ARF or COC may be returned to sender.

Order Confirmations (OC) for requested analyses will be emailed within 3 business days of sample receipt. **Please review the confirmation email closely, as mistakes missed at this time may cause substantial delays or inaccuracies in analytical reporting.**

QUOTATIONS

Written quotations are available by request (analytical@hazenresearch.com). Quotations are valid for 90 days unless otherwise noted. A copy of the quotation must accompany an order to ensure proper billing for the analyses performed. Please include the quote number on the ARF.

TURNAROUND TIME (TAT)

Routine analyses are normally reported by email within 10–15 business days for non-radiochemistry analyses but may take longer for radiochemistry analyses.

Back to top

GENERAL INFORMATION

Priority service is available at a 100% surcharge. Priority service ensures that your samples will be prioritized over standard service samples. Results are delivered by phone or email. **Prior arrangement is required to ensure availability – please email analytical@hazenresearch.com before sending your sample.** Results are delivered by phone or email, typically within 5–7 working days after sample receipt. However, these services do not guarantee results within the number of days specified. Some procedures or combinations of procedures require additional time. Advance scheduling of sample submittals may result in faster turnaround times.

PRICING POLICY

It is the policy of the Hazen laboratories to set prices at a fair and equitable level for quality analytical services. While we attempt to maintain the listed rates, the prices are subject to change without notice. Specific test methods and pricing may not be applicable to all sample types. In these cases, the customer will be notified and, if appropriate, a special price quotation will be provided.

All prices are in U.S. dollars (US$), and unless otherwise specified, are per sample. (See the Minimum Charges section below).

On large projects, we are frequently able to provide discounts. These are offered by quotation only.

MINIMUM CHARGES

Our Quality Assurance (QA) program requires, at a minimum, one blank, one duplicate, and one calibration check standard be analyzed with each group of 10 samples, or with each significant matrix. Our minimum charges (minimum samples charged per analysis) help offset the cost of Quality Assurance and Quality Control (QA/QC) procedures and other handling costs for small quantity orders. For certain analyses, sample billing minimums are required; the minimums are listed for the applicable determinations.

Replicate analyses requested in addition to the minimum QC samples are charged at the regular rate of a single analysis.

Back to top

QUALITY ASSURANCE/QUALITY CONTROL

We maintain a QA/QC program to assure reliable results. We maintain a supply of certified standard reference materials for a wide variety of matrices and analytes, which allows us to provide better matching between reference material and samples. In many cases, we have alternate methods that can be used to confirm values obtained by our standard methods. Our results are reliable, but we encourage customers to contact us if data do not meet expectations. Since quality is important to us, we will, within reason, verify results. If the results confirm the original data, there will be an additional charge for the confirmation analysis.

Our standard report includes client sample results. If QA control sample data are required, a formal report can be provided at an additional 25% surcharge, for a minimum fee of $50. These data include associated raw data, including adjacent blank, control values, and duplicates associated with your sample(s). Contact Hazen for information on customized data deliverables and QA/QC packages.

Back to top

Back to top

ANALYTICAL REPORTS

Analytical reports are sent by email as signed PDF files. Upon request, reports will additionally be provided by first class mail for $2. The analytical request form must include a valid mailing address. Most reports can be supplied in electronic data deliverable (EDD) or other custom electronic reporting formats.

All results are held in strict confidence. Results will be released to a third party only if authorized by the original client in writing.

Any special reporting instructions should be included on your ARF.

TERMS AND PAYMENT

Terms are net 14 days from the date of invoice. A 1.5% per month surcharge will be assessed on all past due accounts. If a purchase order is used as a form of payment, its terms and conditions do not apply and are not binding on Hazen.

In the event of default on payment, the client is responsible for all reasonable collection and legal fees. By sending samples for analysis, client agrees that services shall be governed by Hazen's analytical terms and conditions (page 2 of the Analytical Request Form); Hazen's terms and conditions supersede all other terms and conditions.

We accept cash, check, purchase order, electronic payment, or credit card (Visa, MasterCard, American Express, and Discover) for payment of services. Credit card limit is $2,500. Payments can be made online at www.hazenresearch.com.

New clients may be required to pay 50% before beginning analysis.

LIMITS OF LIABILITY AND WARRANTY

It is the intent of Hazen's laboratories to provide the most reliable data possible for contracted analyses. These services are provided without warranty or liability, implied or otherwise, of any kind. The sole remedy shall be limited to repeating the analyses or refunding the amount paid to Hazen for services provided.

Back to top

SAMPLE STORAGE, RETURN AND DISPOSAL

All samples remain the property of the client.

Any unused portion of samples will be returned to the client at a fee of $4 per sample ($15 minimum return fee) unless prior arrangements have been made for pickup or disposal of non-hazardous samples. If sample disposal has been arranged, Safety Data Sheets must be provided to verify that samples meet requirements for non-hazardous disposal classification. A fee of $4 per sample will be charged for disposal.

A minimum $50 surcharge will be added to orders requiring special packaging and labeling as hazardous materials.

Samples will be returned to the client 30 days after reporting. Radiochemistry water samples will be disposed of 90 days after reporting.

If you waive the return fee in lieu of in-person pickup at the Hazen facility, there will be a **$50 per month per order** storage charge for remnant sample not picked up within 100 business days of completion of report.

SPECIAL LICENSING

We are certified by Colorado Department of Health and Environment (CDPHE) for drinking water radiochemistry and inorganic chemistry analysis.

We are licensed by USDA Annual and Plant Health Inspection Service to ship, recycle, and dispose of unsterilized soil from foreign sources or domestically quarantined areas. **Please contact us for a copy of our permit before shipment.**

Treatment and disposal of samples and containers handled under this permit have a fee of $50 minimum per sample batch.

SAMPLE PREPARATION

Back to top

Preparation or Determination	Fee
Routine Preparation	
Rock and ore	$25 for first the 2 lb $3 per lb for each additional lb
Coal	$25 for the first 5 lb $3 per lb for each additional lb
Wood and biomass	$25 for 1 gal container or smaller; $100/h for larger quantities
Industrial waste	time basis, $100/h
Municipal waste	$25 preparation; $20 moisture analysis
Small samples requiring hand mortar and pestle	$45 per sample
Metals and alloys requiring drilling (excludes tool steels and extremely hard alloys)	$45 per sample
Samples over 10 lb	time basis, $100/h
Cryogenic preparation with liquid N_2 (up to 10 lb)	$50 per sample
Custom Preparation	
Crushing of rock and ore (up to several tons)	by quote
Drill core sawing and splitting	by quote
Batch grinding (wet and dry) in mild steel and ceramic mills	by quote
Blending, compositing, and sample charge preparation	by quote
Particle Size Distribution	
Basic dry screen analysis using Ro-Tap (up to 1 kg, from 1.7 mm to 75 µm, up to 5 size fractions)	$100
Basic wet screen analysis (up to 1 kg, from 1.7 mm to 38 µm, up to 7 size fractions)	$350
Additional sample, size fractions, and or high clay material	by quote
Particle Size Analysis	
Horiba LA-950V2 laser diffraction size analyzer	$200 per sample
Density	
Bulk density (loose and packed)	
Le Chatelier flask	
Stereopycnometer (Anton Paar UltraPyc 5000)	

ASSAY STANDARD PREPARATION

We offer customized assay standard preparations (i.e., round robin testing). Please call and ask for Mineralogy to find out more.

SAMPLE QUANTITY REQUIREMENTS

Back to top

Analysis Requested	Weight or Volume	
	Required	Requested
Atomic Absorption (AA)		
Solid	0.2–0.5 g	10 g
Liquid	1 mL	10 mL
Fire Assay (FA), Fire Assay with AA Finish, Fire Assay with ICP–OES Finish		
Solid	30 g	100 g
ICP–OES and ICP–MS		
Solid	0.2–0.5 g	10 g
Liquid	1 mL	10 mL
LECO Carbon, Hydrogen, Nitrogen, Oxygen, or Sulfur		
Solid	2 g	10 g
Particle Size Analysis		
Solid More sample (1–2 kg) required for "coarse material" (>150 µm)	1 g	10 g
Liquid (slurry)	50 mL	100 mL
Radiochemistry		
Gross alpha/beta		
Solid	1 g	5 g
Water	200 mL	1,000 mL
Radium-226 and 228		
Solid per isotope	1 g	5 g
Water per isotope	1 L	2 L
Sludge per isotope	1 g	5 g
Radon (water) (special glass containers)	30 mL	60 mL
Thorium and tritium		
Solids	0.5 g	5 g
Water	1 L	1 L
Uranium		
Solid	0.2–0.5 g	10 g
Water	1 mL	10 mL
Wet Chemistry, Anions, TOC		
Solid	1 g	10 g
Liquid	40 mL	120 mL
XRF		
Solid	25 g	50 g
Biomass	Call for required sample quantities	

ANALYTICAL SERVICES – ELEMENTAL ANALYSIS

Back to top

Individual analytes may be determined by AA, ICP-OES, wet chemistry, or FA.

The fees provided do not include the sample dissolution and/or preparation fee for solid samples.

Determination	Fee	Determination	Fee
Aluminum	$25	Molybdenum	$20
Ammonium	$40	Neodymium	$25
Antimony	$20	Nickel	$20
Arsenic	$25	Niobium	$25
Barium	$20	Nitrogen (Dumas)	$25
Beryllium	$20	Nitrogen (total chemiluminescence)[a]	$50
Bismuth	$20	Palladium (Fire Assay, ICP–OES Finish)	$50
Boron	$20	Phosphorus (Yellow or Blue)	$50
Cadmium	$20	Phosphorus (ICP–OES)	$20
Calcium	$20	Platinum (Fire Assay ICP–OES Finish)	$50
Carbon, total	$28	Pt/Pd (Fire Assay ICP–OES Finish)	$70
Carbon dioxide (carbonate carbon)	$30	Pt/Pd/Rh (Fire Assay ICP–OES Finish)	$90
Carbon, organic	$51	Potassium	$20
Cerium	$25	Praseodymium	$25
Chloride, soluble	$45	Rhenium	$25
Chloride, total	$45	Rhodium (Fire Assay ICP–OES Finish)	$50
Chromium	$20	Samarium	$25
Cobalt	$20	Scandium	$20
Copper	$20	Selenium	$30
Copper, oxide	$20	Silicon	$20
Dysprosium	$25	Silver (Fire Assay)	$30
Erbium	$25	Silver (AA)	$20
Fluorine	$40	Sodium	$20
Gadolinium	$25	Strontium	$20
Gallium	$20	Sulfur, total	$22
Germanium	$20	Sulfur, sulfate	$35
Gold (Bullion)	$70	Sulfur, sulfide	$55
Gold (Fire Assay, gravimetric)[a]	$30	Sulfur, elemental	$45
Gold and silver (Fire Assay, gravimetric)[b]	$35	Tantalum	$20
Gold (Fire Assay, AA Finish)[b]	$40	Tellurium	$20
Gold and Silver (Fire Assay, AA Finish)[b]	$45	Thallium	$20
Hafnium	$25	Thorium	$70
Holmium	$25	Thulium	$25
Indium	$20	Tin	$20
Iron	$20	Titanium	$20
Lanthanum	$25	Tungsten	$40
Lutetium	$25	Uranium	$45
Lead	$20	Vanadium	$20
Lithium	$25	Yttrium	$25
Mercury	$70	Ytterbium	$25
Magnesium	$20	Zinc	$20
Manganese	$20	Zirconium	$20

[a]5 sample billing minimum

[b]To exhaustion – will be charged by number of boats it takes to complete analysis

Back to top

ADDITIONAL DETERMINATIONS

Determination	Fee
Acid, insoluble	$30
Loss on ignition	$20
Ash %	$30

SOLID SAMPLE DISSOLUTION

Preparation Method	Fee
4-acid digestion	$15
2-acid digestion	$10
Fusion	$20
Parr bomb	$20
Leach	$10

LIQUID SAMPLE PREPARATION

Preparation Method	Fee
Filter sampling	$15

Back to top

INDUCTIVELY COUPLED PLASMA–OPTICAL EMISSION SPECTROMETRY (ICP–OES)

Quantitative Multi-Element Analysis

METALS SCAN $155
Elements Included: Al, As, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cu, Fe, K, La, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Re, S, Sb, Sr, Te, Th, Ti, V, Y, Zn, Zr

A four-acid digestion method is used to bring sample into solution, and the solution is analyzed by ICP–OES. This suite is appropriate for non-refractory materials. Aluminum, arsenic, barium, sulfur, titanium, and zirconium are not truly quantitative using this dissolution method and analysis.

RARE EARTH SCAN $180
Elements Included: Al, Be, Ca, Ce, Cr, Dy, Er, Eu, Fe, Gd, Hf, Ho, K, La, Lu, Mg, Mn, Na, Nb, Nd, P, Pr, Sc, Si, Sm, Ta, Tb, Th, Ti, Tm, Y, Yb, Zr

Lithium metaborate/lithium tetraborate fusion of the sample followed by acid dissolution, and solution analysis on ICP–OES. This method is appropriate for highly refractory materials and other difficult-to-digest samples.

For custom ICP–OES analysis suites, please contact us.

Back to top

INDUCTIVELY COUPLED PLASMA–MASS SPECTROMETRY (ICP–MS)

ICP–MS[a]	Fee
First element	$70
Any additional element	$10 per element
ICP–MS Rare Earth Scan (Ce, Dy, Er, Eu, Gd, Ho, La, Lu, Nd, Pr, Pm, Sm, Tb, Tm, Yb)	$230
ICP–OES and ICP-MS Scan (Ag, Al, As, Au, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cu, Dy, Eu, Fe, Ga, Gd, Ge, Ho, In, Ir, K, La, Li, Lu, Mg, Mn, Mo, Na, Nb, Nd, Ni, P, Pb, Pd, Pr, Pt, Rb, Rh, Ru, S, Sb, Sc, Se, Sm, Sn, Sr, Tb, Th, Ti, Tl, Tm, U, V, Y, Yb, Zn, Zr)	$470

[a]Most elements from atomic mass 6 to 238 can be determined by this technique. In clean matrices, such as deionized water, detection limits are sub parts per billion (μg/L) for the majority of elements. Quantifiable elements and actual detection limits vary with sample matrix and required sample decompositions. Our ICP–MS capabilities include both reaction and collision cell technology. This allows for the elimination of isobaric ICP–MS interferences for a variety of elements, providing lower detection limits and improved precision and accuracy.

Back to top

X-RAY FLUORESCENCE (XRF)

Bruker S8 Wavelength Dispersive XRF

XRF can analyze elements sodium through uranium at concentrations ranging from 50 ppm to 100%. Loose powders, pressed powder pellets, and borate fusion prep methods are used. Multiple packages are offered and project-specific methods can be developed for high throughput/volume applications by request.

Semi-Quantitative & Qualitative Multi-Element Analysis

QUANTEXPRESS LOOSE POWDER ANALYSIS.....$65

Elements reported: Ag, Al, As, Au, Ba, Bi, Br, Ca, Cd, Ce, Cl, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Gd, Ge, Hf, Hg, Ho, I, In, Ir, K, La, Mg, Mn, Mo, Na, Nb, Nd, Ni, P, Pb, Pd, Pr, Pt, Rb, Re, Rh, Ru, S, Sb, Sc, Se, Si, Sm, Sn, Sr, Ta, Tb, Te, Th, Ti, Tl, U, V, W, Y, Yb, Z, Zr

A finely ground sample is mixed with binder, pressed into a pellet, and a full XRF scan is conducted. Specific wavelength intensities are measured and fundamental parameters concentrations are assigned to the specified intensities. This is a qualitative method only, and is appropriate for general materials characterizations.

Quantitative Multi-Element Analysis

BORATE FUSION WHOLE ROCK PACKAGE.....$130

Borate fusion analytes by XRF: Al2O3, CaO, Fe2O3, K2O, MgO, MnO, Na2O, P2O5, SiO2, SO3, TiO2, Ba, Ce, La, Nb, Sr, Ta, Th, U, Y, Zn, Zr, Loss on Ignition (LOI)

Following sample fusion into a glass disc, major mineralogical elements are determined and reported as oxides. Loss on ignition is also determined. This method is suitable for non-sulfide ores, silicates, feldspar, gypsum, bauxite, and limestone. It is not appropriate for sulfide content greater than 1%, precious metals, or PGM analysis.

Back to top

ANALYSIS FOR ORGANIC HALOGEN (Cl+Br+I reported as Cl) (3 samples per test billing minimum)	Matrix	Fee
Total Organic Halogen (TOX) - Duplicate analysis required for EPA SW-846-9020	Water	$100
Extractable Organic Halogen (EOX)	Soil	$100
Total Halogen (TX)	Any	$80

ION CHROMATOGRAPHY (IC) (3 samples per test billing minimum)	Fee
Quantitative Anion Determination (F^-, Cl^-, Br^-, NO_3^-, SO_4^{2-}, PO_4^{3-})	
First anion	$55
Each additional anion	$25
IC Anion Scan (Cl^-, Br^-, NO_3^-, SO_4^{2-}, PO_4^{3-})	$150

ANALYSIS FOR ORGANIC CARBON (3 samples per test billing minimum)	Matrix	Fee
Total Organic Carbon (TOC)	Water	$35
Trace Total Organic Carbon (TOC)[a]	Water	$45
Dissolved Organic Carbon (DOC)	Water	
Total		$50
Trace		$60
Total Organic Carbon by Difference	Soil	$50
Colorado State Drinking Water Package for TOC[b]	Water	$180
Colorado State Drinking Water Package for SUVA[c]	Water	$185
Certified Clean TOC Bottles (per bottle)	Water	$3 ($10 minimum)

[a]Trace implies a detection limit below 1 mg/L (usually 0.05 mg/).

[b]The TOC and SUVA packages include certified sample bottles, cooler, field blank, fortified sample and laboratory QC, and reporting on forms as required by the State of Colorado for sampling one treated and one untreated water source.

[c]For State of Colorado reporting, SUVA package requires TOC package.

Back to top

OTHER DETERMINATIONS (3 samples per test billing minimum)	Fee
Nitrogen (chemiluminescence detection to sub ppm levels)	$50
Basic Nitrogen	$35
Density or Specific Gravity (liquid)	$25
Flash Point (closed cup Pensky-Martens)	$60
Water, Karl Fischer Direct Injection (add $15.00 surcharge for solvent dilution)	$40
Water, Karl Fischer (furnace drying, purging water into K. F. titrator)	$60

ANALYTICAL SERVICES – COAL AND BIOMASS

Back to top

Coal, Biomass, and Refuse Derived Fuels Analysis	Fee
Ash	$30
Moisture, Ash, Sulfur, BTU (short proximate)	$100
Elemental Ash Analysis (requires ash preparation of sample) Al_2O_3, CaO, Fe_2O_3, MgO, MnO, P_2O_5, K_2O, SiO_2, Na_2O, SO_3, TiO_2	$220
Gross Calorific Value, Heat of Combustion (BTU)	$40
Carbon Dioxide	$30
Moisture	$25
Carbon	$25
Hydrogen	$25
Nitrogen (LECO)	$25
Carbon, Hydrogen, Nitrogen	$75
Sulfur (LECO)	$25
Proximate Analysis (Moisture, Ash, Volatile Matter, Fixed Carbon)	$80
Proximate, BTU, S	$140
Ultimate (C, H, N, S, Ash, Moisture, O by Difference)	$145
Ultimate (C, H, N, S, Ash, Moisture, Direct O)	$165
Ultimate, Proximate (O by Difference)	$170
Ultimate, Proximate (Direct O)	$200
Ultimate, Proximate, BTU (O by Difference)	$190
Ultimate, Proximate, BTU (Direct O)	$220
Volatile Matter	$30
Chlorine	$45
Dry Screen (up to 12 size fractions)	$100
Bulk Density (Loose or Packed)	$35
Fusion Temps of ash (Ox or Red) per sample	$55
Water-Soluble Alkalis[a]	$50

[a]Single or group metals available. Call and ask for Fuel Lab for price/information.

Petroleum Fuel and hazardous wastes analysis will be 25% more per analysis per sample.

Fees do not include sample preparation. See sample preparation fee list on Page 6 for solid samples that are not received minus 60 mesh or finer.

Back to top

Elemental Microanalysis Samples with limited sample amount (<2 g) (3 samples per test billing minimum)	Fee
Carbon and Hydrogen	$35
Carbon, Hydrogen and Nitrogen	$50
Hydrogen	$25
Nitrogen (chemiluminescence)	$50
Nitrogen (instrumental Dumas)	$25
Nitrogen (Kjeldahl)	$70
Oxygen	$40
Oxygen (Merz) in the presence of reducible metals or phosphorus	$60
Phosphorus	$35
Sulfur	$30
Ash	$30
Sulfated Ash	$40
Carbonate Carbon	$30
Total Carbon	$25
Total Organic Carbon by Difference (includes Total and Carbonate Carbon determinations)	$45
Moisture, Loss on Drying	$25

Back to top

Water Analysis (3 samples per test billing minimum)	Fee
Acidity	$30
Alkalinity (Total as $CaCO_3$)	$25
Alkalinity (OH^-, CO_3^{-2}, HCO_3^-, Total)	$35
Bromide	See IC or ICP–MS
Carbon Dioxide	$30
Chloride by Titration (also See IC)	$45
Conductance, Specific	$20
Fluoride by ISE (also See IC)	$40
Hardness (calculation)	$45
Metals	See Page 8
Nitrogen, Ammonia (NH_4^+)	$40
Nitrogen, Nitrate (NO_3^-)	See IC
Nitrogen, Total Kjeldahl (TKN)	$70
Nitrogen, Total (chemiluminescence)	$50
pH	$20
Phosphorus, Total	$20
Silica, Dissolved (as SiO_2)	$40
Solids, Dissolved (TDS)	$40
Solids, Suspended (TSS)	$40
Solids, Total (TS)	$30
Sulfur, Total	$20
Sulfur, Sulfate	See IC
Sulfur, Sulfide	$55
UV absorbance	$40

Water or wastewater samples may require filtration, digestion or other sample preparation prior to analysis in compliance with certain methods and protocols. See Page 9 for applicable charges.

ANALYTICAL SERVICES – RADIOCHEMISTRY

Back to top

Determination[a]	Fee	Volume or Weight Requested
Filtering Fee (for samples containing an excess of solids not removed with single filter paper)	$50 per analyte preparation	
Gross Alpha		
Liquids	$48	1,000 mL
Solids	$71	5 g
Sludge	$71	400 mL
Gross Alpha/Beta		
Liquids	$55	1,000 mL
Solids	$77	5 g
Sludge	$77	400 mL
Radium-226		
Liquids	$77	2,000 mL
Solids	$98	5 g
Radium-228		
Liquids	$118	2,000 mL
Solids	$139	5 g
Sludge	$139	400 mL
Radon in water	$57	40 mL × 2 glass bottles
Thorium can be done by ICP-MS	$70	5 g
Tritium in water (not CDPHE certified)	$80	500 mL
Uranium		
Liquid	$37	5 g
Solid	$70	250 mL
Solid waste preparation	$27	
Solid waste % moisture	$27	
Sample preparation fee	$25 per sample	
Environmental waste management fee	$4 per sample	
Bottle shipping fee	$2 per bottle plus shipping	
Drinking Water Composite Fee	$30	
Minimum charge	$100 per order	

[a]For analysis in this group, please use a Chain of Custody (See Page 1).

Hazen is CDPHE-certified for Gross Alpha/Beta, combined radium (Ra-226 and Ra-228), and uranium in drinking water.

PRECIOUS METALS RECOVERY

Back to top

GRAVITY SEPARATION ..... By Quote

Mineral Technologies spirals; diagnostic heavy liquid separation (HLS); jigs; Wilfley, Deister, and Gemeni shaking tables; Gold Strake Knelson KC-MD3 centrifugal concentrator; Falcon L-40 concentrator; and cyclone size separators are available for gold, silver and platinum recovery.

CHEMICAL PROCESS DEVELOPMENT ..... By Quote

Heap, cyanidation, bottle roll, and agitation leaching, zinc precipitation, carbon-in-pulp process, pressure oxidation, chlorination, roasting, and effluent treatment.

PLACER GOLD RECOVERY ..... By Quote

Pound to ton quantities of deposit material evaluated by gravity and fire assay techniques. Please contact Hazen for more information.

MINERALOGICAL CHARACTERIZATION OF GOLD ORE $5,000

Samples will be subjected to a sizing and upgrading procedure that provides preliminary information on the response to gravity concentration and on liberation–locking and other characteristics pertinent to processing. This procedure also enhances the detection of a statistically valid number of gold particles.

METALLIC ASSAY PROCEDURE $350

Back to top

POLARIZING MICROSCOPY $875

Research microscopes with complete accessories, including digital photomicrographic equipment; used for polarized, transmitted, and reflected light microscopic analysis of rock, ore, and metallurgical product samples, to include mineral identification, paragenesis determination, textures, liberation characteristics, and grain sizes and distributions. Sample preparation not included.

SEMI-QUANTITATIVE X-RAY DIFFRACTOMETRY (XRD) $300

Semi-quantitative XRD utilizes a Bruker D8 Advance with Davinci design and a Lynxeye detector and state-of-the-art software packages to analyze rock samples or mineral mixtures to identify the crystalline phases and determine the relative amounts. Sample preparation includes pulverizing to very fine powder and scanning the powder on the XRD instrument. The technique requires very little material for analysis (minimum of 0.5 g). In some cases, distinct peaks can suggest multiple phases, or interferences due to overlapping peaks that can lead to erroneous interpretation or inconclusive results. In situations like this knowledge of the chemical composition is essential.

QUANTITATIVE X-RAY DIFFRACTOMETRY (QXRD)..... $375

Quantitative XRD utilizes a Bruker D8 Advance with Davinci design and a Lynxeye detector and state-of-the-art software packages to analyze rock samples or mineral mixtures. Results are reported as weight percent of minerals and can be performed using Rietveld Refinement procedures on all crystalline phases. Sample preparation includes pulverizing to a very fine powder and scanning the powder. The technique requires 3 to 5 g of material for analysis. In some cases, distinct peaks can suggest multiple phases, or interferences due to overlapping peaks that can lead to erroneous interpretation or inconclusive results. In situations like this knowledge of the chemical composition is essential.

Back to top

CLAY CHARACTERIZATION …… By Quote

Clay identification can be done on particle size or clay mineral speciation. All mineral particles ≤2 µm are of a clay particles size, but do not necessarily represent a clay mineral species.

Settling, filtration and other associated dewatering problems can be caused by both the particle size distribution and/or speciation of the clay mineral phases present.

This clay characterization scope of work aims to address both these issues and may include, but is not limited to:

- Attrition (where and if necessary)
- Wet screening to acquire either the minus 45, minus 25 or minus 20 µm size fraction. If not agreed upon with the client upfront, screening will take place at 25 µm.
- Filtration of the fines slurry to produce a damp filter cake
- Particle size distribution by Horiba laser diffraction size analyzer on a re-scurried aliquot of the damp filter cake
- XRD by Bruker D8 Advance, with Davinci design and Lynxeye detector on a dried pulverized aliquot of the filter cake to identify the clay mineral species and estimate the proportion of swelling and non-swelling clays. XRD will be conducted on an aliquot of the sample.
    - As Is'
    - Glycolated
    - Heated to 550°C

ELECTRON MICROPROBE – POINT MINERAL/PHASE ANALYSIS …… By Quote

Hazen offers, in conjunction with our business partners at renowned research institutions in Colorado, USA a comprehensive electron microprobe (EMP) analysis service.

This service includes, but is not limited to, quantitative (standardized) point analysis by Energy Dispersive Spectrometer (EDS) and/or Wavelength Dispersive Spectrometer (WDS) on various phases, including minerals, metals, manufactured products and contaminants. The detection limit is approximately 0.1 wt% for the EDS and approximately 0.05 wt% for the WDS. These detection limits are sample and phase dependent. Samples are usually set in epoxy resin, as polished blocks and or thin sections.

Back to top

QEMSCAN – AUTOMATED QUANTITATIVE SCANNING ELECTRON MICROSCOPY ……By Quote

The QEMSCAN is an automated scanning electron microscope (SEM) based instrument, similar to the MLA and TIMA. It provides rapid quantitative analysis of minerals and other inorganic materials. The Hazen QEMSCAN is based on a Thermo Fisher-FEI Quanta 650FEG SEM, with a large specimen chamber, two high speed Bruker XFlash 6/30 SDD energy dispersive spectrometers (EDS) and state-of-the-art iDiscover automated quantitative image analysis software.

The QEMSCAN can analyze a wide range of sample types, including geological samples, such as hand specimens, drill cores and chips, and metallurgical samples, such as concentrator and other processing plant feeds and products. Samples can include both natural and manufactured products. These are usually set in epoxy resin, as polished blocks and or thin sections.

The most common datasets produced include, but are not limited to:

- Bulk mineral composition
- Elemental deportment
- Mineral liberation analysis
- Mineral grain size distribution (GSD)
- Mineral association analysis
- Particle characterization and classification
- Particle size distribution (PSD)
- Precious metal (Au, PGE & Ag) deportment studies
- Trace mineral search analysis, including REEs
- SEM-microscopy
    - Secondary electron imaging
    - Backscatter electron imaging
    - Qualitative and quantitative (without standards) EDS analysis
    - Mineral and elemental mapping

POLISHED SECTION PREPARATION ……$100 per specimen

- Vacuum and pressure epoxy impregnated 30 mm mounts
- Using automated Struers Equipment

MINERALOGY – LIMESTONE SORBENT CHARACTERISTICS

Back to top

LIMESTONE SO2 REACTIVITY STUDY $950
Limestone SO_2 reactivity study by TGA provides a graphic representation of a sorbent's ability to absorb SO_2 from a gas stream. Useful for comparing characteristics of individual sorbents to a database for qualitative rankings.

THERMAL DECREPITATION TEST (STATIC TEST) $300
Certain limestones lose their structural bond when heated, thereby reducing the particle size distribution of the overall sample by decrepitating to smaller particles. Size retention is important for bubbling fluidized-bed applications. Decrepitation may be beneficial in some circulating fluidized-bed applications. Using this test, potential limestone sources are compared and ranked for their relative abilities to resist decrepitation.

DYNAMIC ATTRITION TEST ..... By quote
The static test is not adequate for making comparisons in certain applications. A dynamic test is more appropriate. This procedure evaluates the change in mean particle size of a limestone having a close size range during a two-hour period of high temperature fluidization. The test is conducted in a two-inch fluidized-bed furnace.

COMBUSTION TESTING
The most accurate method for determining the sorbent requirement for reducing sulfur dioxide emissions to an acceptable level is to conduct an actual test. Hazen uses pilot plant fluidized-bed test equipment to conduct these determinations.

Each test requires eight hours. This includes the time required to heat the test stand to thermal equilibrium and to establish steady-state operating conditions.

A cost quotation will be provided upon request. Because of the extensive test work required, this procedure is reserved for making final comparisons. Candidates for testing are usually the two or three highest ranking limestones.

QUICKLIME PROPERTIES
Properties of the quicklime produced from the limestone material are important if the quality of the sample warrants lime production. Standard ASTM procedures can be used to measure characteristics of quicklime produced from calcining the limestone. Slaking rate and hydrate acid neutralization potential are included. Contact our pyrometallurgy department for a quotation.

Back to top

Breakage_Characterization–JK Tech_Procedures	Fee
Full drop-weight test procedure (requires 80–100 kg of minus 4-inch material)	$6,000
SAG mill comminution (SMC) test (requires 12 kg of 1/4 core or 20 kg of minus 2-inch rock)	$2,500
Integrated full drop weight and SMC test (requires 80-100 kg of minus 4 in. material)	$7,000
Bond rod mill grindability (requires 25 kg of minus $^1/_2$-inch material)	$1,000
Bond ball mill grindability (requires 12 kg of minus 6-mesh material)	$1,000
Bond abrasion test (requires 1.6 kg material, $^3/_4$ inch by $^1/_2$ inch)	$450
SAG feed belt cut particle size distribution, up to 500 kg	$3,500

The cost per test includes sample preparation, engineer oversight, and reporting. For larger samples (greater than four times the sizes listed above), please contact us for pricing. Sample disposal or shipping is not included in the cost.

VISCOMETRY

Back to top

Listed prices are for determinations performed on common matrices and at standard or noted conditions. High temperatures and/or unusual matrix requests are quoted individually.

Viscometry	Instrument	Fee
Rheology, rotational, non-Newtonian materials	Anton-Paar RheolabQC	$200
Viscosity, rotational, Newtonian fluids	Brookfield LVT	$150
Viscosity, falling sphere, Newtonian fluids	Gilmost	$125

Temperature control at 0–90°C for all methods.

Fees do not include sample preparation. See the Sample Preparation List on Page 6 for solid samples coarser than 150 mesh (100 µm).

THERMAL ANALYSIS

Back to top

Thermal Analysis	Fee
LIMESTONE	
SO_2 Reactivity Study by Thermogravimetric Analysis (TGA)	$950
Limestone SO_2 reactivity study by TGA provides a graphic representation of a sorbent's ability to absorb SO_2 from a gas stream; useful for comparing characteristics of individual sorbents as a qualitative ranking.	
Customized run conditions, simultaneous techniques, and analytical interpretation assistance available on request, by quote.	By Quote
THERMOGRAVIMETRIC ANALYSIS (TGA)	
Samples up to 1,000°C	$450
Samples up to 1,400°C	$650
Determines weight losses or gains of a sample as a function of temperature or time to study weight changes and oxidation reactions under programmed heating rate conditions.	
Macro TGA (Samples up to 1,100°C)	$750
Determines the weight loss or gains of a sample as a function of temperature using a sample cup up to 5 mL to generate a larger sample for additional analysis.	
SIMULTANEOUS ANALYSIS	
Samples up to 1,100°C	$450
Samples up to 1,400°C	$650
THERMOGRAVIMETRIC ANALYSIS AND DIFFERENTIAL SCANNING CALORIMETRY (TGA/DSC)	
Samples up to 1,100°C	$750
Samples up to 1,400°C	$950
Simultaneously measures the weight losses or gains of a sample and the heat associated with the chemical or physical changes occurring in the material as a function of temperature or time.	
THERMOGRAVIMETRIC ANALYSIS AND DIFFERENTIAL THERMAL ANALYSIS (TGA/DTA)	
Samples up to 1,100°C	$750
Samples up to 1,400°C	$950
Simultaneously measures the weight losses or gains of a sample and detects the temperature difference between a sample and an empty reference cup. The DTA records the temperature difference as endothermic or exothermic reactions occurring in the sample. Can be used to measure temperatures of phase transitions, melting points, volatilizations, and dehydrations.	
HEAT CAPACITY	
Samples up to 1,100°C	$1,500
Samples up to 1,400°C	$2,000
Measures the heat capacity of a material by comparing the DSC signal to a known reference material in an inert atmosphere at a slow heating rate. This can be useful in determining the heat requirement of a material within a system. For multiple analyses, each additional sample cost is $750. Customized run conditions (heat rate, soak temperature/time, atmospheres), simultaneous techniques, and analytical interpretation assistance are available on request, by quote.	