Breaking Boundaries

An Integrated Service offering across the Resources Cycle

GEOCHEMISTRY > METALLURGY > MINE SITE > INSPECTION

RIGHT SOLUTIONS | RIGHT PARTNER
Core Values

- Honesty and Integrity
- Exceeding Client Expectations
- Belief in our Ability
- Hard Work and Continuous Improvement
- Doing it Better
- Celebrating Success
- Safety as a Priority.
Overview

ALS Minerals is the leading full-service provider of testing services for the global mining industry in four key service areas:

- Geochemistry
- Metallurgy
- Mine Site Laboratories
- Inspection

With more than 120 laboratories and offices, and employing 4,000 staff in key mining provinces and trade ports on six continents, ALS Minerals provides unparalleled global coverage for a dynamic industry that seeks consistency, reliability, quality, mobility, versatility and technical leadership from service providers. The ALS Minerals service offering covers the entire resource life-cycle from exploration, feasibility, production, design, development through to trade, and finally rehabilitation.

Service, Quality, Deliverables and Technical Leadership... it’s the ALS way.
Geochemistry

ALS Geochemistry provides analytical procedures appropriate for all “elements or mineral assemblages of interest” which are tailored to meet the needs of exploration geologists, miners, mineral processing engineers and metallurgists. Our data is utilised for exploration, mine grade control, concentrate and bullion determinations, acid-base accounting as well as process plant control and ore characterisation or treatment studies.

ALS Geochemistry operates a Global Enterprise Management System (GEMS) at all permanent laboratory locations and ensures that ALS work procedures are standardised and tracked at every step, from initial log-in/sample submittal, through the all-important sample preparation stages and finally analytical determination.

The standard range of analytical methods offered covers all commodities from precious metals to iron ore and industrial minerals. Methodologies include those used for lithogeochemistry, trace and indicator element analysis, ore grade determinations, isotope determinations, hydrogeochemistry, biogeochemistry, selective leach geochemistry and mineralogy evaluations.

Metallurgy

ALS Metallurgy is the market leader in bankable metallurgical testing services for mineral process flowsheet development and optimization. With hub facilities based in the major mining centres of Perth (Western Australia), Kamloops (British Columbia) and Santiago (Chile) in addition to local specialised facilities, the group is well placed to service major projects and offer commodity customised solutions. Our facilities are equipped with state-of-the-art equipment to handle and prepare a large range of sample types including hazardous and radioactive materials. ALS Metallurgy offers both bench scale and large scale pilot plant facilities and expert metallurgists to provide mineral processing, hydrometallurgical, and mineralogical testing services.
Mine Site

ALS Mine Site coordinates the services of the ALS Minerals Division (Geochemistry, Metallurgy, Inspection) and other ALS Group offerings (Environmental, Industrial) to provide tailored solutions delivered at your mine or port site. Regardless of commodity, location or breadth of service requirements, ALS Mine Site can package comprehensive laboratory testing solutions to meet site requirements. ALS Mine Site custom designs, builds, installs, commissions and operates mine site and port site laboratories, with signature ALS Quality, Service and Deliverables to provide mining and metallurgical process plant support.

Inspection

ALS Inspection inspects, weighs, samples, analyses and reports on the quantity and quality of commodities to produce findings that can be used for final commercial settlement purposes. Providing accurate, global inspection and analysis services for metals, minerals, ores, precious metals, ferro alloys and solid fuels, ALS Inspection is one of the foremost umpire and party analysis laboratories in the world. Teams of surveyors are strategically located at major ports, smelters, refineries and steelworks around the world to undertake precise inspection and sampling of commodities. Samples are dispatched to primary analytical laboratories in UK, Holland and South Africa with analytical results being used for commercial exchange purposes between buyer and seller.
Technology and tools to promote exploration success

ALS Geochemistry offers a comprehensive suite of analytical services beyond traditional assay results, paired with powerful data integration and visualization tools.

New technologies backed by proven science are being added to the exploration toolbox faster than ever. But producing, integrating and making sense of large data sets in disparate formats remains a stumbling block for exploration companies of every size.

Our global laboratory network and strategic partnerships with developers of cutting-edge exploration technology enables quick and informed decisions on project viability, early in the exploration life cycle, like never before.

**Sample Preparation**
- Mobile Sample Prep and Mine Site Services
- Core Photography / Core Cutting
- Sample Storage
- Sample Preparation Packages
- Individual Sample Preparation Methods
- Specific Gravity, Bulk Density and Miscellaneous Methods

**Precious Metal Analysis**
- Gold
- Silver and Platinum Group Elements
- Concentrates, Bullions and Metallurgical Testing

**Generative Exploration**
- Super Trace Analysis for Soils and Sediments
- Ionic LeachTM
- Selective Leaches
- Hydrogeochemistry and Biogeochemistry

**Carbon, Sulfur, ABA and Concentrates**
- Carbon & Sulfur Methods
- Acid-Base Accounting
- Concentrates

**Targeted Exploration**
- Ultra Trace Level Methods
- Trace Level Methods
- Low Grade Mineralized Materials
- Individual Elements and Miscellaneous Methods
- Stable Isotopes and Geochronology

**Whole Rock Analysis, Lithogeochemistry and Mineralogy**

**Specific Ores and Commodities**
- Ores, High Grade Materials and Massive Sulfides
- Santiago Mineral Services Center
- Iron Ore Technical Center
- Rare Earths and Rare Metals
- Bauxites, Laterites, Phosphates and Other Commodities

**Modeling and Geostatistics Software Packages**

- MAPTEK® Vulcan™
- leapfrog®
- MICROMINE®
- GAS®
Unlock the full power of spectral mineralogy on drill core, chips, crushed rock and more.

Field and core shed observations can be supported by proven technologies in time for seasonal decisions. Imagine the ability to orient your position in the ore deposit system using mineral assemblages ahead of the drilling schedule. A variety of industry leading hyperspectral technologies can be applied to your project, with next-generation interpretation software tying it all together.

Combine, visualize and share core photos, mineralogy, geochemistry and more, online.

Conduct a virtual core shed visit with colleagues across the world from the comfort of your own offices using ALS CoreViewer™. Pair high resolution core photography with depth-registered data in an intuitive and easy-to-use interface for unparalleled visualization and interpretation, or compelling presentation graphics. Geochemistry, mineral statistics and maps from hyperspectral analysis, downhole geophysics and any other results that can be paired with depths on drill core or chips may be added to CoreViewer™ - all archived in perpetuity with secure online access.

Integrate and interrogate with 3D modeling and geostatistical software.

Geochemical and mineralogical data produced by ALS Geochemistry can already be exported into any file format appropriate for your database or information management system. We’re taking it a step further and enabling you to one-click import your results into iOGas™, the leading geostatistical software package in the industry, directly from ALS Webtrieve™ - no file downloads or tedious manual transfer required.

It’s always important to check and double-check any geological model against the reality that underpins it. From inside your 3D deposit modeling program of choice, you can select a drill hole at any depth and open ALS CoreViewer™ to the same hole and depth - instantly ready to compare core photos, mineralogy and key commodity elements against the model. Bringing it back to the rocks has never been easier.

Spectral Mineralogy Partners
# Commodity Customised Solutions

## Communition
- Autogenous Media Competency
- Bond Abrasion Index
- Bond Ball Mill Work Index
- Bond Impact Crushing Work Index
- Bond Rod Mill Work Index
- Comparative Ball Mill Index
- Grind Establishment
- High Pressure Grinding Rolls (HPGR) – Batch & Pilot
- JK Drop-Weight
- Levin Open Circuit Grindability
- Metso Jar Mill
- Point Load
- SABC – Pilot
- SAG Mill Communion (SMC)
- SAGDesign – Starkey
- Ultra Fine Grinding – IsaMill™, Metso Vertimill, Stirred Media Detritor (SMD), Deswik, Metprotech
- Unconfined Compressive Strength

## Geometallurgy
- Geology, Mineralogy, Metallurgy Production Mapping

## Gold
- Activox®
- Agitated Cyanide Leaching – Vat & Bottle Roll
- Bacterial Leaching
- BIOX® Bacterial Oxidation
- Carbon Activity
- Carbon Characterisation
- Carbon Desorption Studies
- Carbon Elution & Electrowinning
- Carbon-In-Leach (CIL) – Batch & Pilot
- Carbon-In-Pulp (CIP) – Batch & Pilot
- Carbon Loading Studies
- Cyanide Detoxification
- Diagnostic Gold Analysis
- Flocculation/Settling
- Floation
- Gold Deportment Studies/Process Mineralogy
- Gravity Separation
- GRG Studies
- Heap Leaching Amenity
- Lime Demand
- Mercury Amalgamation
- Merrill-Crowe Zinc Cementation
- Oxygen Enhanced Leaching
- Oxygen Uptake Rate Determination
- Preg-Robbing Characterisation
- Pressure Oxidation
- Rheology
- Roasting – Batch & Pilot
- Ultra Fine Grinding – Batch & Pilot

## Gravity Separation
- Cyclone Separation
- Dense Media Separation (DMS)
- Falcon Concentrator
- Heavy Liquid Separation (HLS)
- Jigging – Allmineral Alljig®
- Kelsey Jig
- Knelson Concentrator
- Manual Panning
- Spiral Rig
- Superpanner
- Teeter Column
- Up-Current Classifier – Allmineral Miniflux®
- Wilfley Table

## Heavy Liquid Separation (HLS)
- TMF/Clerici’s Solution up to 4.05SG

## Hydrometallurgy
- Acid & Alkaline Leaching
- Agglomeration & Percolation
- Agitation Leaching – Batch & Pilot
- Atmospheric Leaching – Batch & Pilot
- Bacterial Leaching
- Bottle Roll Leaching
- Diagnostic Leaching
- Electrowinning Circuit – Fully Integrated
- Heap Leaching – Batch & Pilot
- Precipitation
- Pressure Leaching – Batch Autoclave Pressure Acid (PAL)
- Resin-In-Pulp – Batch & Pilot
- Resin-In-Solution – Batch & Pilot
- Resin-Ion-Exchange – Batch & Pilot
- Solution Purification
- Solvent Extraction – Mixer-Settler Batch Laboratory & Pilot
- Vat Leaching

## Flotation
- Base Metal Flotation
- Batch & Bench Scale Flotation
- Column Flotation
- Controlled Potential Sulphidisation (CPS)
- Deslime Flotation
- Flash Flotation
- Flotation Kinetics Rate
- Grind & Regrind
- Iron Ore Flotation
- Large Scale Flotation – 10 to 50kg
- Locked Cycle Flotation
- Pilot Flotation Plant – Multi-Circuit/Capacity Options
- Pilot Flotation Plant – Transportable/Site Optimisation Work
- Reverse Flotation
- Sulphide/Non-Sulphide/Oxide Flotation
- Xstrata Technology – Jameson Cell Flotation

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# Global Capability Statement

## Iron Ore
- Allmineral Alljig® Laboratory Jigging Unit
- Allmineral Miniflux® Up-Current Classifier
- Autogenous/Semi-Autogenous Grinding (AG/SAG) – Batch & Continuous
- Automated Drop Tower – 15m Drop – Lump/Fine Ratio
- Beneficiation – Gravity, Magnetic, Flotation
- Bulk Density/Apparent Relative Density/True SG
- Davis Tube Recovery (DTR)
- Davis Tube Separation versus Grind Size
- Ericson Cone Heavy Media Separation
- Floation
- HylLoggerTM Core Mineral Analysis
- ISO/JIS Decrepitation
- ISO/JIS Reduction Disintegration Index
- ISO/JIS Tumble Strength
- Magnetic Separation – Dry & Wet LIMS Separation – Batch & Pilot
- Magnetic Separation – WHIMS (ERIEZ, SLON) – Batch & Pilot
- Midrex Acceptance
- Permroll High Gauss Separator
- Pilot Scale Crushing, Screening & Splitting Plant
- Scrubbing – Batch & Pilot
- Spiral Rig
- Stratification Jig
- Willfley Table Gravity Separation

## Pilot Plant – Large Scale Testing
- Assays – In-House – Rapid Turn Around
- Atmospheric Leach
- Autogenous/Semi-Autogenous Grinding (AG/SAG) – Batch & Continuous
- Automatic Data Recording System
- Ball/Rod Grinding & Re-Grind Mills
- Bivi-TEC® Screen
- Bulk Sample Hazardous/Non-Hazardous Preparation Facility
- Bulk Sample Preparation – Crushing, Screening, Grinding, Splitting
- Bulk Sample Preparation – 200 Tonne Blending Facility
- CIL/CIP
- Crushing Equipment
- Dense Media Separation Pilot Plant – Transportable/Site Work
- Electrowinning Circuit – Fully Integrated
- Engineering Work Shop Facilities
- Filtration Technologies
- Flash Flotation
- Floation – Conventional & Column
- Floation – Xstrata Technology Jameson Cell
- Gravity Separation
- Grinding Equipment
- Heap Leaching
- High Pressure Grinding Rolls (HPGR)
- Hydrocyclone Separation
- Magnetic Separation – Dry & Wet LIMS Separation
- Magnetic Separation – WHIMS (ERIEZ, SLON)
- On-Site Pilot Plant Operations
- Pilot Floation Plant – Multi-Circuit/Capacity Options
- Pilot Floation Plant – Transportable/Site Optimisation Work
- Pilot Scale Crushing, Screening & Splitting Plant
- Screening – Wet & Dry
- Solvent Extraction – Pilot Scale Mixer-Settler
- Spiral Plant
- Tailings Facility
- Tanks – Agitated, Water Storage
- Thickeners
- Ultra Fine Grinding – IsaMill® & Deswik
- XRF – Desk Top – Pilot Control Samples
- XRF – Hand Held – Pilot Control Samples

## Pyrometallurgy
- Batch Roasting – Muffle & Rotary Midrex
- Dorr-Oliver Pilot Scale Fluidised Bed Reactor – Continuous

## Sample Preparation/Sizing
- Attritioning
- Blending
- Bulk Density
- Bulk Sample Hazardous/Non-Hazardous Preparation Facility
- Compositing
- Crushing
- Cyclsizing
- Desliming
- Grinding
- Laser Sizing
- Moisture Content Determination
- Particle Size Distribution Analysis
- Pulp Density Determination
- RoboLab Sample Preparation
- Screening – Wet/Dry
- SG True Mineral, Apparent/In-Situ
- Size-by-Size Analysis
- Splitting

## Slurry Characterisation
- Filtration
- Rheology
- Slurry Flocculation & Settling
- Transportable Moisture Limit (TML)

## Other Services
- Approvals for Radioactive Ore Processing & Storage – C Class Radiation License
- Australian Quarantine & Inspection Service (AQIS) Approved
- Dangerous Goods License
- On-Site Plant Optimisation Studies & Technical Assistance
- Sample Storage – Large Scale – Ambient Temperature Storage
- Sample Storage – Large Scale – On-Site Purpose Built Cold Storage

## Mineralogical Services
- Environmental SEM
- HylLoggerTM Core/Chip Mineral Analysis
- Mineral Analysis – QEMSCAN®, MLA
- Process Mineralogy Studies/Monthly Composite Analysis
- Traditional Optical Microscopy
- X-Ray Diffraction (XRD)
Your Site... Our Quality Scope, Service and Deliverables

Expertise in sample processing, laboratory efficiency, economies of scale and a global network – present at your mine site.

ALS experience in successfully delivering 21st century onsite and online solutions for mine site testing saves costs and adds value. The ALS onsite solution allows miners to focus on mining and milling, while we focus on delivering high quality, on-time, cost effective analyses.
Onsite mine and process support laboratories

- Design and build new mine site laboratories
- Expand, debottleneck, optimise and/or upgrade existing mine site laboratories
- Mobile containerised laboratory facilities for both sample preparation and analysis
- Expand mobile containerised facilities into full service analytical laboratories
- Operate, manage and maintain mine site laboratories – new and existing
- Full operational responsibility, including technical management, staffing and maintenance
- In-house engineering, project management, design, construct and fit-out team
- Laboratory equipment supply and install
- Inventory management (consumables, purchasing)
- Health, Safety and Environment compliance
- Quality management systems and technical oversight
- Training, consulting and onsite support
- Laboratory audits
- Secure Data Management – LIMS, Webtrieve™, Core Viewer™, 3D mine planning integration
- Grade control analysis
- Exploration analysis
- Metallurgical process plant control analysis
- Sample collection
- Sample preparation
- Instrumentation (AAS, XRF, ICP-AES/MS)
- LOI/TGA
- Fire Assay – AAS, ICP, gravimetric finish
- Screen fire assay for particulate gold analysis
- Aqua Regia Acid Digest – AAS, ICP finish
- BLEG, LeachWELL™
- Classical chemistry
- Carbon and sulphur analysis
- Bullion analysis
- Davis Tube Recovery (DTR)
- Moisture analysis
- Bulk density, specific gravity
- Particle size distributions
Marine Inspection

ALS Inspection marine surveyors accurately calculate cargo weights, ensure that appropriate storage and handling methods are employed and evaluate vessel condition prior to and during loading to protect your financial interests.

Throughout any inspection, ALS Inspection provides total support complete with regular progress updates. Final technical reports detail weight results and sampling procedures within predetermined timescales.

Inspection and Surveying

It is our responsibility to protect your interests by obtaining fully representative sample material and determining the accurate weight of your commodities.

ALS Inspection offices are led by a team of experienced inspectors, samplers and marine cargo surveyors with expert knowledge of local procedures and equipment, who work in accordance with international standards.

Our field operatives are supported by commercial, technical and administrative teams providing two-way communication for you.

Services include:

- Pre-shipment Inspection
- Supervision of Loading / Transhipment / Discharge
- Monitoring Cargo Handling
- Quantity and Quality Inspection
- Store Intervention / Warehouse Inspection
- Storage and Stowage Inspections
- Tallying and Stockpile Control
- Calibration of Weighing Equipment
- Weight Control / Supervision: Draft Survey, Barge Gauging, Scale Weighing
- Sampling in full accordance with international standards to ensure accurate analytical results
- Sample Preparation
- Size Distribution
- Granulometry
- Moisture Determination
- Transportable Moisture Limit / Flow Moisture Point

Solid Fuel

ALS Inspection specialises in sampling, preparation and analysis of coal and coal-products such as anthracite and coke. Global inspection and testing services are coordinated and controlled by our dedicated, permanent team of experts based at all major receiving ports.

Analytical

ALS Inspection undertakes precision analysis of nearly 80 elements of the periodic table. Our traditional assaying methods are combined with cutting edge analytical instrumentation. We are committed to providing routine sample analysis in time-frames to meet and exceed client expectations.

ALS Inspection staff have a clear understanding that with client deadlines pressing, priority fast and accurate analysis reports is a sector expectation. The ALS Inspection process is geared towards transparent tracking and delivering to this priority.

Precious Metals

ALS Inspection is established as a leading global supplier of precious and platinum group metal inspection and analytical services acting for clients in sectors including the mining, chemical, oil, petrochemical, pharmaceutical, electronic, jewellery, financial and government sectors.

The ALS Inspection network provides coverage of all of the major Precious Metals and PGM refineries and production facilities around the world, many with permanent representatives.

ALS Inspection offers a complete range of independent inspection, weighing, sampling, sample preparation and precision analytical services for a wide range of precious metal bearing materials. Our coverage includes all processing stages including drying, incineration, crushing, milling, blending, screen grading, moisture determination, loss on ignition (LOI), leaching, chemical treatment, melting, matting, sawing, drilling and alloying, weighing and stock verification.
Metals, Minerals and Ores

Highly trained and experienced ALS Inspection surveyors are supported by comprehensive technical, operational, commercial and customer service teams to keep clients informed throughout the movement of commodities. Our surveyors are strategically located to cover major ports, warehouses, smelters and refineries globally.

ALS Inspection recognises the responsibility to protect client interests – obtaining fully representative sample material and determining the accurate weight of commodities. Our surveyors ensure that sampling for moisture determination and quality purposes is performed in accordance with the highest of International Standards.

Representative samples are dispatched to our main hub analytical laboratories with assay results being used for commercial exchange purposes between seller and buyer. The ALS Inspection flagship commercial laboratory in the UK is one of the leading laboratories of its type in the world.

Our UK hub laboratory specialises in the identification of chemical elements across a wide range of materials associated with metals, minerals, concentrates and mining ores.

Commodities Supervised include:

- Base Metal Ores & Concentrates
- Precious Metals including full Platinum Group Metals
- Recycled Metal Scraps and Residues
- Noble Metals
- Other Non-Ferrous Ores, Concentrates, Metals & Alloys
- Catalyst Materials
- Steel Products
- Chemicals
- Iron Ore & Pig Iron
- Ferrous Scrap (Steel)
- Coal & Coke
- Rare Earth Minerals
- Ferro Alloys
- Nonferrous Scrap (Copper, Brass etc)
- Minor Metals
- Electronic Scrap (E.g Circuit Boards)
ALS Environmental

ALS Environmental provides a full range of environmental analytical testing and monitoring services. Our analytical services include chemical, biological, physical, radiological and microbiological testing. These capabilities cater to a number of distinct sectors including drinking water, water quality, acid mine drainage, air quality, dust, occupational hygiene and stack testing. To complement the analytical service ALS Monitoring and Technical Services group design, install, operate and maintain a wide range of environmental monitoring systems. Mine clients utilise these to monitor physical and quality parameters using real time data on weather, water levels, dust and flows to support business, quality and compliance decisions.

ALS Asset Care

ALS Asset Care is a leading provider of asset reliability and integrity services. Services and solutions assist clients to maximise production, extend asset life and ensure safe and reliable plant operation.

ALS approaches asset health from a holistic perspective, considering both asset reliability and integrity. Starting with an engineering approach – seeking to understand client asset management or maintenance issues first – the right package of services and solutions to improve and sustain asset health is then delivered.

ALS has a proven track record in the power, oil & gas/petrochemical, minerals processing, mining and water and infrastructure industries.

ALS Tribology

Tribology is the science and study of friction, lubrication and wear.

Whether to reduce costly repairs, limit unplanned downtime, increase equipment availability, extend oil drain intervals or evaluate product performance, ALS provides the testing solutions to help improve maintenance practices. ALS operates as a totally independent oil, fuel, coolant, and metalworking fluid analysis service with the largest global laboratory network in the industry.
Health, Safety and Environment

SAFETY AS A PRIORITY

Safety Management

ALS has developed an industry leading standard for managing health, safety and environmental issues.

In addition to safety specific quality documentation, safety is a part of all operating work instructions. The objective of the Safety Management System is to continually improve performance. HSE documentation is on a permanent review cycle to ensure instructions are relevant and up to date. ALS HSE procedures are available for review upon request.

Real time reporting of NMI, MTI, FAI and LTI via a series of automated alerts is available to staff, HSE operatives and management.

Assessment of Safety Performance

The Positive Performance Indicators (PPI) program assesses and actively reports the performance of individuals and operations from a proactive HSE perspective with respect to Leadership, Training, Injury Management and Process Compliance. The program and web based reporting tool encourages and rewards ownership and transparency of HSE issues.

Protection of the Environment

ALS has extensive procedures and policies to ensure protection of the environment. Specific procedures and policies address the following issues:

• Waste management, monitoring and maintenance;
• Disaster management plans for spills;
• Management of solid waste, with recycling where possible.

Quality

ALS believes that one of the foremost deliverables is the provision of exceptional quality data to our clients. This is facilitated through specifically designed processes and a global quality management system that meets the requirements of International Standards ISO/IEC 17025:2005 and ISO 9001:2008. On every continent, ALS has laboratories accredited to ISO/IEC 17025:2005 for specific procedures, while the majority of our laboratories have attained ISO 9001:2008 certification.

The ALS quality program includes monitoring sample preparation and analytical quality control data generated by laboratories, inter-laboratory test programs, and regular internal audits. Quality is an integral part of day-to-day activities, involves all levels of ALS staff and is monitored at senior management levels.

Please contact us for details regarding the scope of ISO registration at individual laboratories.

Global Capability Statement | 15
Global head offices

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