Bankable Metallurgical Solutions
Testwork Services and Capabilities

RIGHT SOLUTIONS | RIGHT PARTNER
Core Values

Our Core Values are simple and we incorporate these in our daily operations, never forgetting the foundations of our success:

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

ALS Metallurgy is part of the ALS Group, a diversified and global analytical laboratory and testing services company.

ALS Metallurgy is the global leader in metallurgical testing and consulting services for mineral process flowsheet development and optimisation.

Extensive bench scale laboratory, large scale pilot plant facilities and expert metallurgists, provide mineral processing, hydrometallurgical, mineralogical and in-plant services to the global resources community.

Our metallurgical solutions are internationally recognised by the mining, engineering and financial sectors for all major commodities:

- Precious metals - gold, silver, platinum group metals
- Base metals - copper, cobalt, lead, zinc, molybdenum, manganese
- Iron ore - hematite, magnetite, goethite, itabirite
- Nickel - laterite & sulphide ores
- Uranium & thorium
- Rare earth minerals & other exotics
- Mineral sands
- Industrial minerals
- Tungsten & tin

ALS Metallurgy has an enviable reputation for delivering the highest quality extractive metallurgical testing service with accurate and timely data, expert support and a culture of safety and innovation.
Australian Laboratory Services (ALS) commenced operations in Brisbane as ‘Australian Laboratory Services Pty Ltd’ in 1974 as a privately owned company providing analytical services for the oil shale and mineral exploration industries.

Australian Laboratory Services (ALS) provides a broad range of sophisticated, state-of-the-art services to four main market segments, with a total of 13 unique service offerings:

**Minerals** – Geochemistry | Metallurgy | Mine Site | Inspection

**Life Sciences** – Environmental | Food | Pharmaceutical
Animal Health | Electronics.

**Energy** – Coal | Oil & Gas

**Industrial** – Asset Care | Tribology.

ALS has demonstrated over 30 years of strong business performance with global revenues exceeding $1.5 billion. ALS continues to remain at the forefront of the testing services industry, building an enviable reputation as the provider of choice on a global scale.

Processing more than 20 million samples per year, our 13,000 staff operate from over 350 locations in 55 countries. We have laboratories strategically located around the world, operating in Australia, Asia, North America, South America, Europe, the Middle East and Africa; and are one of the largest analytical laboratory groups in the world.
Quality

ALS understands the value of data quality and integrity to exploration and mining companies. Our processes are designed to ensure clients receive the best quality assay data to assist informed decision making. The ALS quality program consists of a series of checks and balances with monitoring at senior management levels. Our global information management system provides oversight and access to all processes. The online Webtrieve™ tool provides client access to this quality information.

All ALS Geochemistry facilities are accredited to the higher of ISO 9001-2008 or ISO 17025 standards as appropriate to the services offered at each location.

Health, Safety and Environment

Being an employee of ALS is about putting safety first. Globally, ALS is committed to a safe work culture.

SAFETY MANAGEMENT

As part of this global approach, ALS has developed an industry leading standard for managing health, safety and environmental issues.

At a local level, safety is a part of all work instructions however, some are specifically set to achieve policy objectives. The focus of the Safety Management System is to continually improve HSE performance and therefore documentation is constantly reviewed. Procedures and policies are specifically targeted toward safety in laboratories and related activities and as such are designed to comply with the requirements of industry best practice. Procedures are available upon request.

ALS is very proactive with respect to safety reporting. Real time reporting of NMI, MTI, FAI and LTI with a series of automated alerts is available to staff, HSE operatives and management alike.

ASSESSMENT OF SAFETY PERFORMANCE

Not satisfied with an improved performance in HSE ‘lag’ statistics, ALS launched a program of Positive Performance Indicators (PPI) in 2010. The 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.
**Metallurgical Testwork Services & Capabilities**

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### COMMUNICATION

- 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
- Leivo Open Circuit Grindability
- Metso Jar Mill
- Point Load
- SABC – Pilot
- SAG Mill Comminution (SMC)
- SAGDesign – Starkey
- Ultra Fine Grinding – IsaMill, Metso Verti-mill, 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
- BIOXX® 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
- Flotation
- Gold Department Studies/Process Mineralogy
- Gravity Separation
- GRG Studies
- Heap Leaching Amenability
- 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)
- Ericson Cone Heavy Media Separation
- 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
# Testwork Services and Capabilities

## 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
- Flotation
- HyLoggerTM Core Mineral Analysis
- ISO/JSM Decrepitation
- ISO/JIS Reducibility
- 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
- Wilfley Table Gravity Separation

## METALLURGICAL ANALYTICAL SERVICES
- Aqua Regia Gold Analysis
- Atomic Absorption Spectrometry (AAS)
- Carbon, Sulphur by CS 2000
- Check & Referee Assaying
- Classical Chemical Analysis
- Comprehensive Water Analysis
- Diagnostic Gold Analysis
- FeO by Titration
- Fire Assay Gold, Platinum & Palladium Analysis
- Inductively Coupled Plasma – Mass Spectroscopy (ICPMS)
- Inductively Coupled Plasma – Optical Emission Spectroscopy (ICP-OES)
- Non-Carbonate Carbon by CS 2000
- Ore Grade Elemental Analysis
- Sample Preparation
- Selective Digestion Techniques
- Shipment Samples
- Specific Gravity – Helium Pycnometer
- Sulphur Speciation
- Thermogravimetric Analysis – Loss on Ignition (LOI)
- X-Ray Fluorescence (XRF) – Fusion

## MINERALOGICAL SERVICES
- Environmental SEM
- HyLoggerTM Core/Chip Mineral Analysis
- Mineral Analysis – QEMSCAN®
- Process Mineralogy Studies/Monthly Composite Analysis
- Traditional Optical Microscopy
- X-Ray Diffraction (XRD)

## 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 – Crush, Screen, Grind, 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
- Flotation – Conventional & Column
- Flotation – 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 Flotation Plant – Multi-Circuit/Capacity Options
- Pilot Flotation Plant – Transportable/Site Optimisation Work
- Pilot Scale Crushing, Screening & Splitting Plant
- Screening – Wet & Dry
- Solvent Extraction – Pilot Scale Mixer-Setter
- Spiral Plant
- Tailings Facility
- Tanks – Agitated, Water Storage
- Thickeners
- Ultra Fine Grinding – IsaMillTM & 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
- Composting
- Crushing
- Cyclosizing
- 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
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