ALS Mine Site

Mine Site Laboratory Services - Gold

Your Site...Our Quality, Scope, Service & Deliverables

RIGHT SOLUTIONS | RIGHT PARTNER

Introduction

Gold and other precious metals continue to be highly sought after by mining and exploration companies worldwide as a result of their strong prices in recent years. ALS has the analytical tools and years of mine site laboratory experience to assist this potentially valuable search.

Selection of the most appropriate method for the determination of gold content in a sample is dependent on the nature of the sample matrix, the grain size and distribution of the gold and the end use of the assay data.

The objective of assays and analysis routinely carried out on gold plants by mine site laboratories is to provide information to optimise the mining process:

- Ore reserves;
- Plant feed;
- Plant performance;
- Loss to tailings;
- Product purity; and
- Health, Safety and the Environment (HSE).

Fire assay or an acid digest followed by determination via Atomic Absorption Spectroscopy (AAS) or Inductively Coupled Plasma (ICP) is used to determine the gold content of solids to help define ore reserves, plant feed, plant performance and loss to tailings.

In gold processing using cyanidation, analysis of solution pH is performed to achieve both HSE and metallurgical objectives. Low pH promotes the generation of toxic hydrogen cyanide (HCN) gas from cyanidation tanks.

Bullion analysis is performed to determine the purity of the final product.

These are just some of the assays and analyses which contribute to ensuring that gold processing is optimised.

There are many other services that are needed to maintain safe, efficient plant production:

- Cyanide solution strength;
- pH and alkalinity;
- Carbon activity;
- Ore hardness;
- Moisture;
- Bulk density;
- Bottle roll cyanidation;
- Mineralogy; and
- Metallurgical testwork and piloting.

ALS can accommodate full testing requirements for gold mining operations at an on-site laboratory or a nearby ALS network laboratory.

Scope of Services

- Design and build new mine site laboratories;
- Expand, debottleneck, optimise and/or update existing mine site laboratories;
- Mobile laboratory facilities for both sample preparation and analysis;
- Expand mobile laboratory facilities into full service analytical laboratories;
- Operate, manage and maintain mine site laboratories - new and existing;
- Near mine site laboratory analysis solutions;
- Grade control analysis;
- Exploration analysis;
- Metallurgical process plant control analysis - Free Cyanide, pH, Carbons, Solutions;
- Sample collection;
- Sample preparation;
- Fire assay - AAS, ICP, gravimetric finish;
- Screen fire assay for particulate gold analysis;
- Classical chemistry;
- Aqua Regia Acid Digest - AAS, ICP finish;
- Carbon and sulphur analysis;
- BLEG, LeachWELL™;
- Bullion analysis;
- Secure Data Management – LIMS, Webtrieve™, CoreViewer™, 3D mine planning integration;
- Laboratory audits;
- Inventory management (consumables, purchasing);
- Training and consulting;
- Moisture analysis;
- Bulk Density, Specific Gravity; and
- Particle size distributions.

Auxiliary supporting testing and inspection services include

- Metallurgical testwork for process optimisation;
- Advanced mineralogy technologies;
- Commercial settlement analysis - inspection of concentrate, doré, bullion;
- Environmental analysis for water, soil, tailings; and
- Oil condition monitoring for the mining fleet.

Gold Determinations

The two most common methods for determining gold in solids are either Fire Assay or an Aqua Regia acid digest, followed by Atomic Absorption Spectroscopy (AAS). Prior to the determinative stage, the highest degreee of care should be exercised during sample preparation to accommodate the variable nature of gold ores.

Fire Assay

For quantitative analysis of gold, the fire assay procedure is the preferred choice globally. It should however be recognised that a wide variety of minerals and metals such as chromite, base metal sulphides and oxides, selenides and tellurides in moderate to high concentrations can interfere with the fire assay process, generally leading to low precious metal recoveries. With prior knowledge of the presence of these minerals and metals, ALS can modify flux constituents and increase flux to sample ratios to improve recoveries. Mine site laboratories that analyse more than one ore type may well use a separate flux formulation for each.

To cope with the ever increasing demand for gold assays, ALS laboratories have focused on increasing productivity through the introduction of larger furnaces, mechanical sample/flux mixing equipment and multi-pour systems. This has resulted in the standardisation of fire assay crucibles to a shape that allows efficient use of the furnace floor space.

Aqua Regia Acid Digest – Atomic Absorption Spectroscopy (AAS)

Wet chemistry can be a robust alternative to fire assay for the analysis of gold. Roasting is a prerequisite when samples contain carbon. Carbon can adsorb gold as it is dissolved, thereby impacting recovery. The aqua regia technique provides gold results that correlate well to those obtained by fire assay provided samples are pre-treated appropriately. The technique is well suited to grade and mill control analysis.

Cyanidation

For mining applications and exploration, cyanide leach tests are used to establish extraction efficiency. Alternatives include cold cyanide extraction, hot extraction and preg-robbing affinity. Pre-robbing of gold during cyanide leaching occurs when the leached gold is adsorbed by certain components of the ore and not recovered.

Cyanide extractable gold by bottle roll assay is a logical method for grade control in mines that employ CIL or CIP gold recovery circuits. The technique often provides superior reconciliation with actual gold production in contrast to fire assay.

The use of accelerated cyanide leaching equipment employing the patented LeachWELLTM reagent requires only 1-2 hour leaching time. Equipment is available to simultaneously pulverise and leach 50 raw samples (typically 0.5kg) per hour. The result being a dramatic reduction of analysis time and capital investment in comparison to fire assay.

Cyanide leachable gold or the maximum potential gold that may be recovered from a plant for a particular grind size may be determined by cyanidation. Cyanidation is usually performed by bottle roll where the rotation of a bottle promotes excellent agitation. A 500g sample is placed in a 4 litre bottle with 500ml of water. The appropriate quantity of lime is added to obtain a pH > 9.0 if using saline water, or > 10.0 if using fresh water. Sodium cyanide is added to 0.5% concentration or to match specific test requirements. The solution is then rolled and sample extracted for a 24, 48 or 72 hour period, depending on the test requirements, prior to filtration and determination of gold content. With the exception of ores, for which the lime and cyanide consumptions are known, pH should be measured at each sampling interval with lime added as required. The sodium cyanide concentration should also be checked at each sampling interval and the concentration adjusted as required. Assays may also be carried out on the solid residue using fire assay or acid digestion techniques.

Carbon

Analysis of process plant carbon samples generated from the adsorption, elution and carbon reactivation circuits is critical to the efficient operation of a gold ore treatment plant. Gold solubilised via cyanidation is subsequently recovered from CIL and CIP leaching pulps using activated carbon. Pregnant carbon from the CIL/CIP circuits is stripped of gold for further processing to generate the final bullion product.

In most gold ore treatment plants carbon samples are removed from various process streams and analysed on site to measure plant efficiency, assist plant metallurgists to monitor plant performance and facilitate metallurgical accounting.

Assaying of the process plant carbon samples to determine the various analytes (precious metals and other co-adsorped analytes) is generally carried out by ashing followed by acid digestion of the residue and analysis by AAS.

Carbon activity testing is required to ensure that the barren carbon which is recirculated from the stripping-elution-regeneration phases of the process plant is capable of efficient adsorption.

Solutions

Leach solutions need to be monitored in the plant and in the laboratory to ensure that operating conditions are maintained to maximise leach efficiency. Cyanide and Oxygen levels must be closely maintained together with pH to provide a safe working environment and prevent the loss of cyanide.

The measurement of pH is used to monitor the alkalinity of leach solutions. From a HSE perspective, leach solutions that have low pH indicating acidic conditions, will release toxic hydrogen cyanide gas.

The appropriate pH level is also dependent on the salinity of the process water.

Free Cyanide

Determination of free cyanide concentration aids in the assessment of 'available cyanide' to leach the gold from the ore. Cyanide levels are usually measured in the makeup water, leach tanks and tailings solutions. Typically cyanide concentration is measured by silver nitrate titration.

Dissolved Oxygen

Dissolved oxygen must be present together with cyanide for the gold to solubilise. It is necessary to measure dissolved oxygen in leach tanks to ensure the concentration is sufficient to maintain the gold dissolution reaction. The concentration of dissolved oxygen in a slurry depends on whether air or pure oxygen is added to the leach tanks. The salinity of the process water and the presence of oxygen consumers in the ore will also influence the dissolved oxygen concentration.

Dissolved oxygen concentration is most easily measured with an ion selective electrode (ISE). An oxygen ISE consists of a gold cathode and a silver anode immersed in an electrolyte and protected from the slurry by a membrane. The membrane itself is ion selective, allowing only oxygen to permeate. The dissolved oxygen is consumed at the cathode generating an electric current that is proportional to the oxygen concentration in the water. The sample or the probe must be agitated during the measurement to stabilise the oxygen concentration in the region of the probe.

World-class testing, inspection and certification expertise delivered right to your mine site.

Outsourcing Models

The specialised mine site laboratory service allows clients to work hand-in-hand with ALS to facilitate laboratory design, equipment and analytical methodology selection, while also optimising staffing and operation options to suit individual mine site specifications. ALS provides a service to allow the outsourcing of capital requirements, engineering, construction, commissioning, maintenance and operation for mine site laboratory facilities; thereby ensuring all components of the project are completed to ALS global standards.

Design and Build

Our mine site and in-house engineering teams, offered though the wholly owned MARC Technologies Group, have years of practical experience providing turnkey mine site laboratory design and construction services. ALS works directly with client in-house mine site teams and/or selected consulting engineers to prepare building layout designs while assisting with equipment selection, manufacture and procurement.

Operate, Manage, Staff and Maintain – New or Existing Mine Site Laboratories

ALS mine site laboratories are run by experienced personnel with full support from an extensive global laboratory network of over 75 minerals testing facilities. Access to global ALS management experience coupled with sufficient staffing and equipment levels ensure high quality data is delivered on-time.

ALS takes full responsibility for the routine upkeep, calibration and validation of the mine site laboratory facilities.

In addition to servicing new start-up mining and mineral processing operations, ALS offers management solutions to existing mine site laboratories - assuming full operational responsibility, including technical management and staffing.

Laboratory Information Management System (LIMS)

In order to meet the demands of the mining industry, ALS can customise the Global Enterprise Management System - GEMS (LIMS) to address specific site requirements. One of the key benefits of this system being that ALS management have the ability to oversee operations from off-site to track performance and quality conditions on site; benchmarking these against global locations to ensure production efficiency and quality.

As a client, direct access to data is available through the online data retrieval system, Webtrieve™, to track and monitor service delivery of geochemical tasks. This highly integrated business system is unique to the industry and distinguishes ALS as a company that delivers unrivalled client solutions.

The consolidated offering of GEMS, CoreViewer™ and Webtrieve™ with 3D orebody software packages such as Leapfrog, Maptek's Vulcan™ and Micromine, set ALS as a clear leader in this space.

ALS is the only laboratory group in the world which can provide this level of integration.

Webtrieve™

Direct secure access to data is available to ALS clients through the online data retrieval system, Webtrieve™, to track and monitor service delivery of analytical tasks and QA/QC information.

ALS is committed to providing Open Lab™ access to laboratories via an online encrypted account allowing secure data access in real time.

The ALS Open Lab™ policy and this highly integrated business system are unique in the industry and distinguish ALS as the company that delivers unrivalled client solutions.

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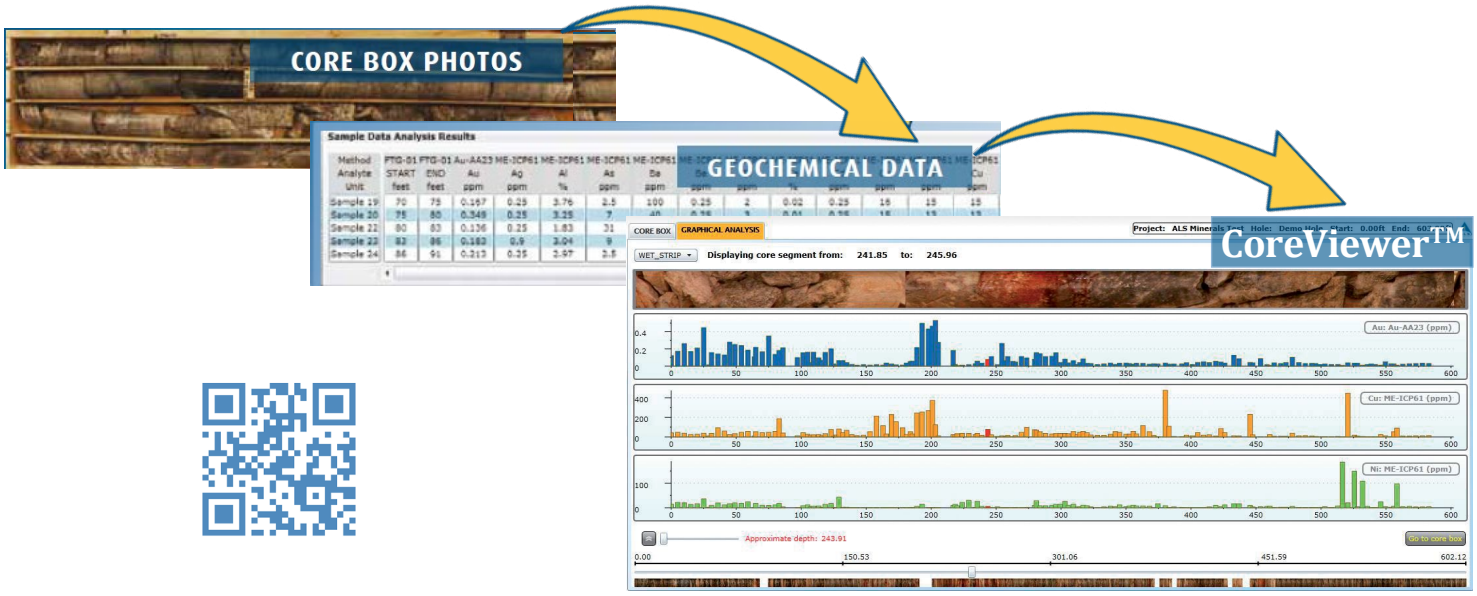
CoreViewer™

ALS offers via its state-of-the-art Webtrieve™ the capability to submit core photos, manage and archive them and plot geochemical data alongside the photograph:

- Core images rendered into single down-hole and depth registered images;
- View core photos with analytical data;
- Interrogation of analytical anomalies;
- Enables interactive inspections of geotechnical and geological features;
- Long term on-line photo archival; and
- Secure, encrypted Webtrieve™ data system.



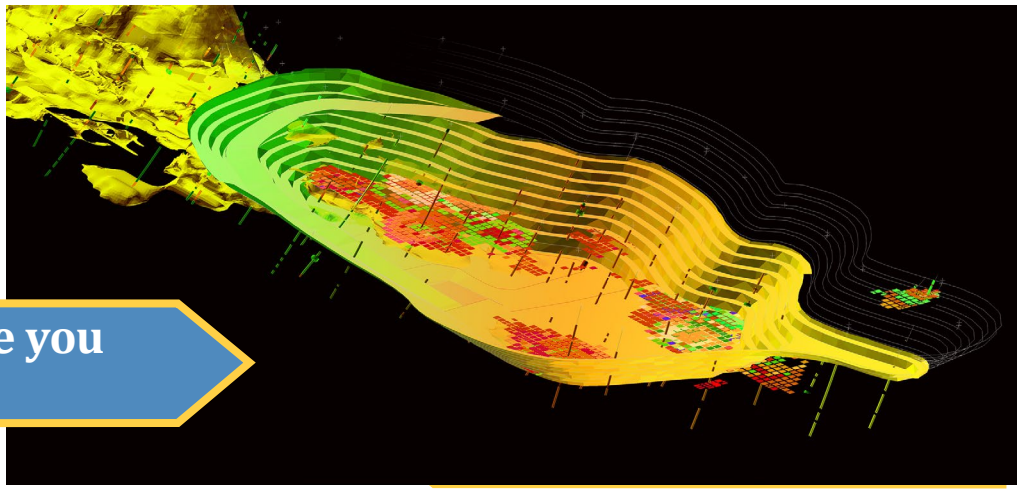
Rapid 3D Ore Model Visualisation with Core Data

ALS Webtrieve™ can interface directly with Leapfrog, Maptek's Vulcan™ and Micromine 3D ore model software.

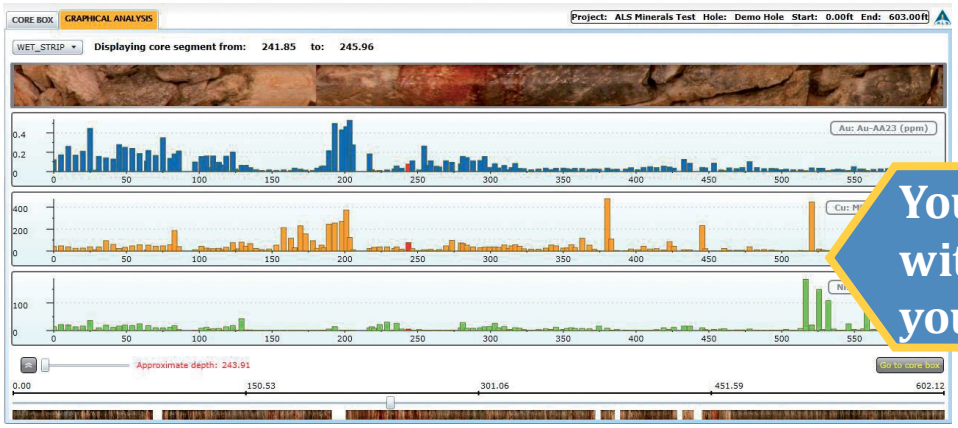
Users of Leapfrog, Maptek's Vulcan™ and Micromine 3D mine planning and geological modeling software can now access core images and geochemistry directly in their 3D geological model, simply by clicking at any point on a drill hole in the model.

Seamless integration of ALS Webtrieve™ and 3D ore model software offers a user many distinct benefits. The software users can view source information as part of their ore body model and quickly visualise core data in 3D. This speeds interpretation, aids collaboration and provides rapid validation for geological and engineering decisions in the complex mine planning and design process.

This cloud-based technology allows users to securely access stored data remotely where web access is available.



Click on the drill hole you want to view



Your selection opens with photos and data in your browser

leapfrog
ACCELERATED GEOLOGICAL MODELLING

MAPTEK™ Vulcan™

MICROMINE
Intuitive Mining Solutions

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.

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 to 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.

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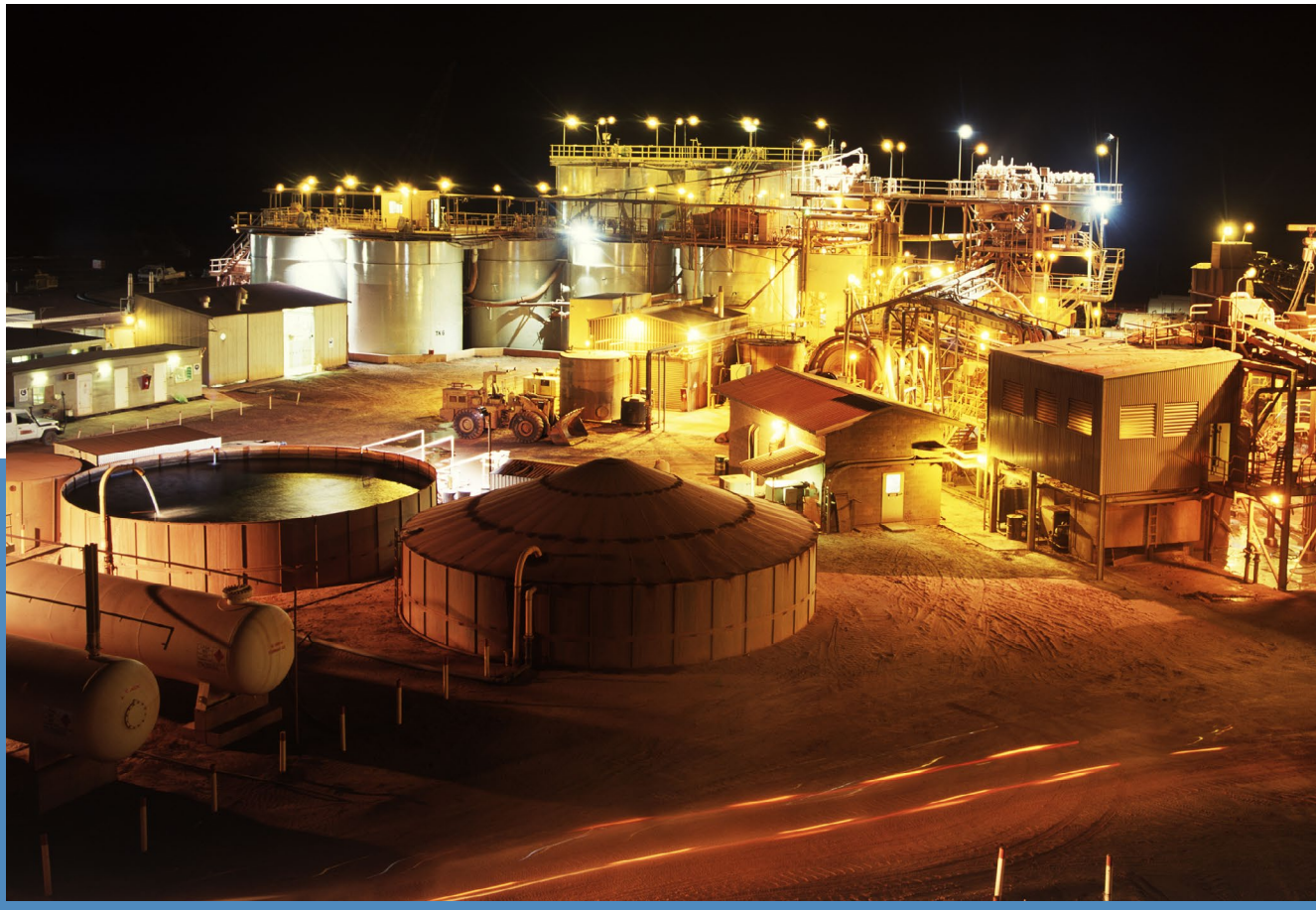

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