

## COMPLETE SOLUTIONS FOR THE METALLURGIST

In the mining industry, ore bodies can materialize differently than what is predicted by best exploration, mine planning and grade control teams. Consequently, mine managers are often faced with poor grade performance and much lower recoveries than were initially predicted.

At AMTEL we have developed new and unparalleled procedures for the mineral characterization of process stream samples. We stand ready to help you optimize the development of ore bodies and mineral beneficiation plants, by identifying potentially problematic issues in the following areas:

**GRAVITY Au**  
Potential issues: Fine, unliberated or flaky particles  
Examined by: Microscopy, stereoscopy, EPMA, AIA, MLA

**FLOTATION Au • Ag • PGE • Cu • Zn • Pb**  
Potential issues: Locking, free metal values in slimes fraction, surface aging and poor collector loading, metal misplacement, conc. dilutants  
Examined by: EPMA, AIA, surface microanalysis

**LEACHING Au • Cu • Ag**  
Potential issues: Locking, refractory gold minerals, submicroscopic gold, dissolution retardants, coatings, preg-robbing and preg-borrowing  
Examined by: TOF-LIMS, TOF-RIMS

**AUTOCLAVE/CIL CIRCUITS Au • Ag**  
Potential issues: Encapsulation, primary and secondary locking, preg-borrowing, preg-robbing, co-precipitation  
Examined by: SIMS, TOF-LIMS

**ROASTER/CIL CIRCUITS Au**  
Potential issues: Residual unburned carbonaceous matter, encapsulation, plating on special steels, glazing, finely disseminated gold-bearing pyrite  
Examined by: SIMS, TOF-LIMS, TOF-RIMS

**LEACHED ULTRAFINE GRINDING TRAILS Au**  
Potential issues: Refractoriness to direct cyanidation, colloidal-size gold, refractory gold, preg-borrowing  
Examined by: SIMS, TOF-RIMS

## ABOUT US

Created in 1993, the Advanced Mineral Technology Laboratory (AMTEL) was formed through a multi-million dollar initiative, sponsored by a consortium of eleven mining companies based in Canada and worldwide.

We are located in London, Ontario, Canada, at the University of Western Ontario Research Park. Our laboratory also has access to facilities based in Guelph and Toronto, Ontario.

## SENDING A SAMPLE

Clients may send the following types of samples for mineralogical analysis:

- Un-crushed grab samples
- Drill core
- Crushed mill flotation products
- Products of a metallurgical process (i.e. gravity flotation, bio-leaching, leaching, roasting and pressure oxidation)

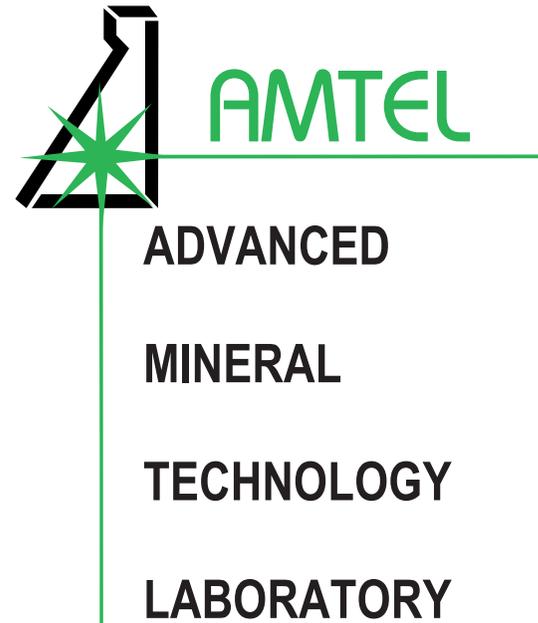
For quotations and detailed sending instructions please contact us.



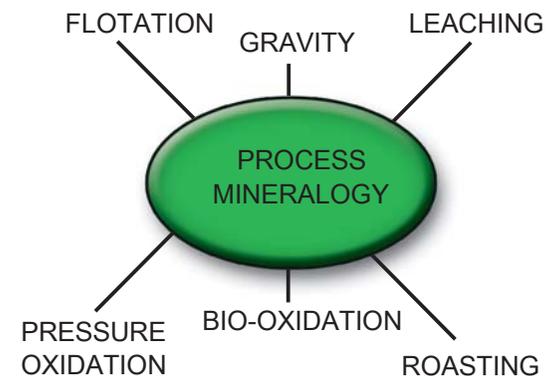
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## Providing solutions to metallurgical problems



## AN INNOVATIVE LEADER IN MINERALOGICAL SERVICES

The Advanced Mineral Technology Laboratory (AMTEL) is an analytical laboratory specializing in mineralogical services. Here at AMTEL, we offer our clients in the mining industry a novel approach to resolving their process related challenges, through a variety of benchmark mineralogical services in various fields:

1. Ore and process mineralogy
2. Process selection, optimization, and innovation based on mineralogy
3. Process mineralogical mapping
4. Department of gold and other precious metals in tailings
5. Characterization of deleterious elements
6. Environmental Studies (e.g. Lead, Arsenic)

## PARTNERS IN YOUR SUCCESS

The AMTEL laboratory is home to a large collection of state-of-the-art micro-analysis equipment, which always provides our clients with accurate, quantitative results.

Our staff is made up of trained specialists with expertise in conducting extensive mineralogical analysis, tailored to your specific requirements.

In today's highly competitive market, AMTEL can provide valuable information and help your operation to:

- Augment recoveries
- Reduce concentrate dilution
- Optimize overall efficiency
- Decrease operating costs



## TOTAL MINERALOGICAL

### MINERAL CHARACTERIZATION

Microscopy is a hub of the AMTEL laboratory and it is used to prepare samples prior to further instrumental analysis. This procedure is used for the characterization of ore minerals in metallurgical samples, and the identification of heavy minerals in gravity separation products. Various microscopes and stereoscopes are used, with capabilities including 3-D vision, up to 1000x magnification and digital photography. In addition, X-ray diffraction (XRD) is used for the identification of minerals by crystal structure.

### LIBERATION ANALYSIS

This procedure provides data in order to establish the degree of liberation, degree of exposure and size distribution of valuable minerals. Liberation analysis is conducted using automated image analysis (AIA), MLA or conventional ore microscopy. It enables the quantification of the sample's mineral composition, and precedes surface and trace element analysis. A reflected light scanning microscope is used as well as an electron microscope, which has back-scattered electron or secondary electron imaging and X-ray EDS mapping capabilities.

### METALLURGICAL TESTWORK

At AMTEL, all mineralogically identified improvements can be backed up by metallurgical test work:

**MILLING** is conducted on pre-crushed samples with associated particle size analysis using metal and nylon screens.

**GRAVITY SEPARATION** is conducted on samples of 5g (heavy media, panning, shaker table) to 20kg (Knelson concentrator) to pre-concentrate mineral particles on a density basis.

**FLOTATION** is conducted on samples weighing 50g-2kg, on which a number of electrochemical conditions are monitored.

**DIAGNOSTIC LEACHING** and cyanidation are frequently performed in support of gold mineralogical analysis. Bottle roll and agitation tests are conducted.

### TRACE ELEMENT ANALYSIS

A variety of techniques are used in the microbeam analysis of elements present in mineral grains at trace concentration levels.

**ELECTRON PROBE MICROANALYSIS (EPMA)\*\*** is used for the quantitative analysis of precious and base metal ore minerals (wt %). It has also been used in various environmental projects and features:

- Energy dispersive X-ray (EDS)
- Wavelength dispersive X-ray (WDS)

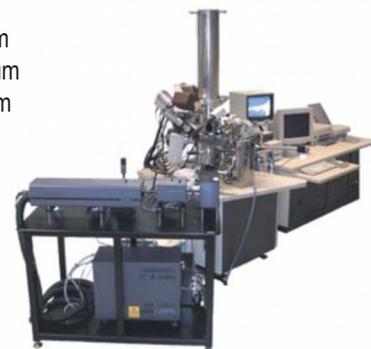
**PARTICLE INDUCED X-RAY EMISSION SPECTROSCOPY ( $\mu$ -PIXE)\*\*\*** is used to detect and quantify gold and other precious metals in rejected sulphide gangue minerals.

**DYNAMIC SECONDARY ION MASS SPECTROMETRY (DYNAMIC SIMS)** is an important element of AMTEL, now the world leader in the mineralogical application of this technique. Its key features are:

- Sensitive routine sample analysis (0.5-5,000 ppm)
- Quantification of precious element content
- Depth profiling and imaging capabilities

**TIME-OF-FLIGHT RESONANT IONIZATION MASS SPECTROMETRY (TOF-RIMS)** was developed at AMTEL in 1999 for mineral analysis. It offers quantitative analysis of the following precious metals at ultra-trace levels (down to 10 ppb).

- Gold
- Platinum
- Palladium
- Rhodium
- Silver



## SUPPORT

### SURFACE ANALYSIS

secondary ion and laser microbeam technology for the analysis of mineral surfaces. We have since developed a wide range of equipment, each performing exclusive functions, specialized to address a specific process-related chemical/mineralogical factor.

**TIME-OF-FLIGHT LASER IONIZATION MASS SPECTROMETRY (TOF-LIMS)** enables the identification of inorganic surface modifiers effecting efficiency of many surface dependent metallurgical processes, such as:

- Flotation
- Leaching
- Electro-deposition
- Cementation

**TIME-OF-FLIGHT SECONDARY ION MASS SPECTROMETRY (TOF-SIMS)** is used to identify and quantify organic compounds, such as collectors, on mineral surfaces. This method is also used to map organic and inorganic species on the surfaces of mineral particles, providing visual evidence on the nature of the surface coating.

**VACUUM ULTRAVIOLET TIME-OF-FLIGHT LASER IONIZATION MASS SPECTROMETRY (VUV TOF-LIMS)**

is utilized for organic surface analysis, by means of vacuum ultraviolet laser ionization. This technique provides minimum fragmentation of large organic molecules and higher detection sensitivity for cationic collectors.

**X-RAY PHOTOELECTRON SPECTROSCOPY (XPS)\***

is used to support other techniques. Applications include cross-reference calibration and determination of the chemical state of elements including sulphur and specific heavy metals, such as arsenic, chromium, and gold on the surface of clustered mineral grains as the analytical spot size exceed typical grain size from mineral beneficiation plants.

### OUR COMMITMENT TO YOU

At AMTEL we are committed to providing the best analytical services to our worldwide customer base. Our experience over time has made us responsive to issues that matter to your operation. In addition to the core services that AMTEL offers, we also provide for our clients:

#### CONFIDENTIALITY

AMTEL has established systematic internal protocols to ensure the confidentiality of your data.

#### QUALITY ASSURANCE

All mineralogically identified improvements can be backed up by confirmatory metallurgical testwork. Independent confirmatory analysis is conducted with every project. All generated data undergoes rigorous verification processes to ensure accuracy and precision. This system enables clients to understand the likely reproducibility of all generated data, while eliminating possibilities of operator error.

#### RAPID TURNAROUND

In order to provide timely information, systems are in place to deliver your data as quickly as possible via email, fax, and courier.

#### FLEXIBILITY

We have experience matching our analytical conditions with those of our customers, which facilitates comparisons between our results and those generated at your in-house laboratory.

#### PROFESSIONAL SUPPORT

Our expert staff is available to deliver specialized seminars and short courses on the utilization of analytical techniques. Upon request, AMTEL professionals will visit your site to gain a better understanding of your operation.

### CONTACT US FOR MORE INFORMATION

\* Located at University of Toronto

\*\* Located at The University of Western Ontario

\*\*\* Located at University of Guelph