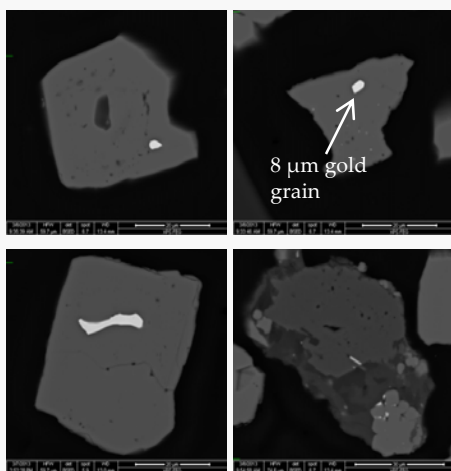


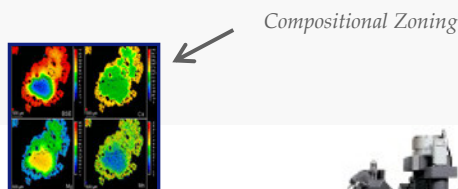
# Diagnostic Gold Mineralogy

## QEMSCAN APPLICATIONS

- Used in conjunction with diagnostic leach analysis
- State of the art QEMSCAN FEG capable of high resolution imaging ( $>5\mu\text{m}$ )
- Find gold grains and gold minerals using Trace Mineral Search
- Pre-concentration and measurement of gravity separates
- Gold deposit mineral characterisation for:
  - Ore and gangue mineralogy, preg robbing minerals
  - Grain sizes
  - Grain shapes, textures and associations
  - Liberation in concentrator or metallurgical test products
  - Quantify diluting minerals in concentrates
  - Quantify form of gold losses in tailings



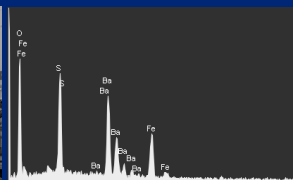
Above: BSE images of Au minerals (bright phases) in pyrite and other silicate minerals taken with the high resolution QEMSCAN FEG.



CAMECA SX-100 Microprobe

## ELECTRON PROBE MICRO-ANALYSIS (EPMA) APPLICATIONS TO GOLD

- The SX-100 EPMA provides low detection limits for most elements
- Check refractory gold in pyrite or arsenopyrite before using SIMS, PIXE or LA-ICPMS
- Determine Au content in electrum
- Check for deleterious elements (e.g. As, Bi, Se and Te) in host gangue and ore minerals such as calaverite and sylvanite
- Analyze for compositional zoning
- Use mineral compositions with QEMSCAN data for calculated assays and metal department



## Gold Processing

Bench Scale Testing • Piloting Testwork • Modeling • Flowsheet Development •

On-Site Plant Support Plant • Surveys • Mineralogy



### BENCH SCALE AND PILOTING CAPABILITIES

- Free Milling Gold Evaluation
- Physical Separation - Gravity Recovery
- Bottle Roll and Agitated Batch Leaching
- Pulp, Heap and Column Leaching
- CIP/CIL Gold Recovery
- Carbon Activity and Ball-Pan Hardness Testing
- Roaster Pretreatment of Refractory Ores
- Flotation Recovery Pre-Cyanidation
- Preg Robbing Investigation
- PARR Autoclave (Pressure Oxidation)
- Effluent Treatment
- Dewatering Optimization
- Crushing and Blending (Small and Large Scale)
- Reagent Screening
- Metallurgical Impact of IsaMilling
- Viscosity Modification



### ADVANTAGES OF CHOOSING XPS

We provide a total solutions package with multidiscipline expertise in Mineralogy and Mineral Processing, Extractive Metallurgy, Process Control and Materials Technology. A dynamic and highly skilled workforce of 55 Engineers, Technicians and Geoscientists from diverse backgrounds around the world is key to our success.

Located in the historical mining centre of Sudbury, Ontario we are easily accessible with transport links by air, road and rail to major North American cities and the world. We provide quality service that is delivered on-time and is competitively priced. Our fully equipped mineral processing and mineral science laboratories along with our continuous 10kg/hr Mini Pilot Plant and 150kg/hr continuous Crushing and Blending Plant put us at the forefront of the industry.

Other services and testing are available. XPS is committed to providing the best service and support needed to maximize recovery and performance of your operation or project. With technical expertise in gold plant operating and optimizing, scopes of work can be tailored to meet your specific needs. Contact us for further information.

## Treatment of Refractory Gold Ores

While the recovery of free milling gold by gravity and direct cyanidation is straightforward and well-established, refractory ores pose a very different challenge to producers.

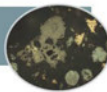
The first challenge is determining the reason for the poor recovery by direct **cyanidation**, which can be caused by one or more contributors. The oldest and best understood is gold locked in sulphide, and most frequently pyrite. The second contributor to refractory behaviour is arsenic, which causes high refractoriness even at low concentrations. The presence of carbon in the ore is also a frequent cause of poor recovery, not because it makes the gold unresponsive to cyanidation but because it readily absorbs gold in solution and leads to “preg-robbing”. When these refractory contributors present themselves in combination, obtaining satisfactory gold recoveries can prove a real headache. Fortunately there are cures.

Key to curing the headache is proper diagnosis of the cause. XPS recommend QEMSCAN for feed characterisation. This analysis may be used in conjunction with a very systematic sequential leaching technique known as a “Diagnostic Leach” which identifies where the gold is in the ore by systematically destroying key minerals, followed by cyanide leaching of the residue until all of the gold has been recovered.



Graphite,  
Organic carbon  
Carbonates

C



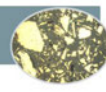
Arsenopyrite  
Enargite  
Realgar

As



Pyrite  
Arsenopyrite

S



Once the cause has been identified, there are a number of alternatives for treating the ore. Firstly, the gold can be made more amenable to cyanidation by ultra-fine milling, followed by a hot atmospheric leach – the Albion Process. A second solution is complete pressure oxidation (POX), which is effective for all conditions except carbon, but this can be expensive. The third method is roasting – either the well-established simple dead roasting to convert pyrite to hematite while oxidising any carbon present, or two-stage roasting to firstly remove arsenic by partial roasting followed by dead roasting.

Since XPS has expertise in fine grinding, pressure hydrometallurgy and pyrometallurgy, it should come as no surprise that these skills have been bundled into a “one-stop-shop” where a client can have the diagnostic leach performed to determine the cause of a particular ore’s refractoriness, followed by a review of the options and a recommendation as to which of the alternatives best suits the client’s needs followed by appropriate testing in XPS’s well equipped laboratories.

With our combined experience in mineral processing, pyrometallurgy, and hydrometallurgy, XPS is well suited for the detailed metallurgical testwork required for successful refractory gold processing.



### FLUID BED ROASTING

Comparative testing of all three options can be carried out at bench scale at XPS using the facilities and expertise on hand. Roasting can be completed in either 2" or 4" diameter continuous fluid bed roasters, each equipped with a cyclone, afterburner for combustion of arsenic and/or sulphur vapour, condenser, and scrubber. Typically, 1-5 kg of feed is sufficient for preliminary comparative evaluation using the 2" roaster, while 20-50 kg can be sufficient for longer duration testing in the 4" roaster. Both roasters are fully instrumented with thermocouples, pressure measurements, and gas analyzers to ensure reliable data capture.



### PRESSURE OXIDATION

Pressure oxidation tests are carried out in a stirred 2L Parr bench-scale autoclave, which typically handles charges of approximately 1 kg. The autoclave is constructed of titanium and can be operated with an optional glass liner. It is fully automated to measure and control the temperature and pressure within the autoclave and the gas flow into the autoclave. The process measurements are captured continuously to a PI server as for the roasters.



### THE ALBION PROCESS

XPS has been engaged in metallurgical testing of ultrafine grinding for several years. We have installed a bench-scale agitated leach tank to collect key metallurgical data for the evaluation of the Albion Process for a given ore or concentrate. The Albion setup at XPS comprises an M4 IsaMill to produce the ultrafines ground ore or concentrate, followed by leaching in an agitated tank at atmospheric pressure. 15 kg of feed is required for determining the signature plot in the IsaMill, but a single Albion leach test can be carried out on 1 kg of ground material.



### CYANIDATION

Having removed the deleterious elements by roasting, pressure, oxidation, or Albion

leaching, the residue from the pre-treatment stage is leached in a cyanide solution to leach out and recover the gold.

