

Over the last 25 years, the variability in base metal prices and gradual decrease in run-of-mine resource grades has impacted on the availability of feedstocks for base metal smelters and on the earning potential of mining projects in general. In addition to tightening supply of high-quality concentrates, smelters are also being faced with higher costs for operating supplies, labor, refurbishment and environmental controls to meet air quality standards and regulations for wastewater and solid waste disposal.

Increasingly, operators and developers of base metal mines are encountering low recoveries and challenges in the production of selective copper, lead and zinc concentrates meeting minimum smelter requirements as a result of processing of lower grade deposits with complex mineralogy. In order to overcome obstacles to economic viability, forward-thinking development strategies for base metals need to be implemented to overcome the issues of:

- Economic recovery of base metals from relatively small, low-grade, isolated or deep deposits;
- Low recoveries and/or low separation efficiencies for payable metals resulting from complex metallurgy or fine-grained nature of deposits;
- Limited net smelter return for concentrates not meeting minimum payable metal grades defined by smelter schedules or that contain elevated concentrations of deleterious penalty elements such as arsenic, mercury, selenium, cadmium, silica, or chlorine / fluorine, and;
- Lack of smelter payment structures for allocating value-added revenue from rare or exotic metals such as indium, tellurium, thallium, gallium or germanium



Figure 1: Copper Flotation Concentrator Plant Designed by Thibault & Associates Inc. (Commissioned in 2012)

Thibault & Associates Inc. specialize in providing innovative process design solutions to overcome technical and economic barriers to the development of base metal projects using a strategic approach that includes:

- Evaluation of earning potential for processing of smaller “satellite deposits” using a centralized milling facility with built-in flexibility to handle a wide range of feedstocks;
- Incorporating unit operations for ore preconcentration either in the mine (to reduce mining and transportation costs) or at surface (to improve mill feed head grades and reduce processing costs), such as:
 - Ore sorting (sensor-based technology that “sorts” ore from waste based on differences in several mineral properties).
 - Dense media separation (separation based on differences in specific gravity).
 - Low or high-intensity magnetic separation.
- Applying our extensive knowledge of surface chemistry principles to the development of highly selective reagent schemes and operating conditions for improved grade-recovery in sequential flotation of base metals;



Figure 2: High Purity Electrolytic Zinc Metal and Indium Sponge Produced from Pilot Program on Bulk Sulphide Concentrate

- Developing business strategies based on value-added production of high-purity metals, oxides, organometallic compounds or metallic salts through hydrometallurgical processing of run-of-mine ore, bulk sulphide or selective base metal concentrates with a focus on:
 - Increasing metal recoveries and reducing milling costs by producing a bulk sulphide or lower grade concentrate.
 - Maximizing opportunities for reagent recycle, beneficial use of solid residues and co-production of rare metals.
- Utilizing customized plant performance monitoring tools, advanced process control techniques and expert systems for process intensification within existing base metal production facilities.

Your Vision - Our Innovation™

For over 28 years, **Thibault & Associates Inc.** has applied process technology innovations to comply with our client's project development strategies, transforming natural resources to high value concentrates, ultra-pure metals, speciality chemicals, transportation fuels or power generation.

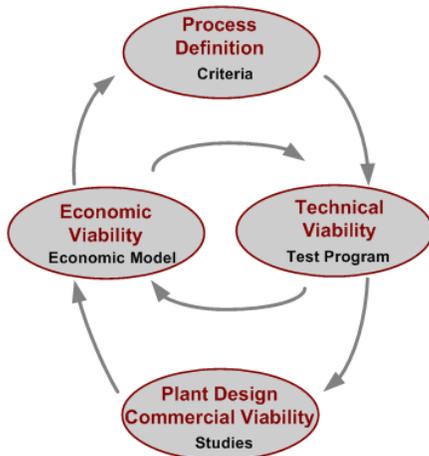
Services

Our firm defines process technology based on the project's earning potential and compliance with product market specifications, environmental protocol and social factors.

We tailor develop process systems to support our client's business plans and our test programs are managed to quantify technical – process design parameters.

As an integral part of process development, we prepare economic models to assess the impact of technical parameters on the project's earning potential.

Our integrated technical and economic studies are based on fully defined process chemistry, equipment selection and plant layout for life of project, heavy industrial process control measures, cost assessment standards, construction and operating practices.



- ✓ Feed characterization and development of process chemistry.
- ✓ Bench scale and pilot test programs.
- ✓ Process simulation and dynamic economic modelling.
- ✓ Independent NI 43-101 technical / economic assessments and feasibility studies.
- ✓ Detailed engineering / multi-discipline plant design, commissioning and aftercare programs.

Speciality

Our clients range from investment firms to heavy industrial producers of base metals, industrial minerals, speciality metals, inorganic chemicals, power, transportation fuels and petrochemicals.

Our project experience covers a wide range of commodities, including:

- ✓ Base metals (Cu, Pb, Zn)
- ✓ Precious metals (Au, Ag)
- ✓ Platinum group metals (Pt, Pd, Rh, Ru, Ir, Os)
- ✓ Oxide metals (W, Sn, Fe, Ti, Al, Cr, Sc)
- ✓ Metals for electronics (In, Y, REO's, Te, Ga, Ge)
- ✓ Specialty chemicals (Sb, V, Mg, K, Si)
- ✓ Battery-grade elements (Graphite, Li, Co, Mn)

In addition to our technical and economic assessment of production opportunities for various commodities, we have specialized in GAP analysis, independent assessment of process development test programs and the transfer of test program data for commercial process plant design, procurement and definitive engineering.

Our most recent base metal projects include:

Development of a Selective Flotation Flowsheet for Centralized Processing of Base Metals In Newfoundland

Technical and Economic Assessment of Processing Options for the Prairie Creek, NWT Base Metal Mine

Economic Assessment of Hydrometallurgical Processing Options for Base Metals Centralized Processing in Northwest Territories

Economic Assessment of Process Base Metals Lundberg Deposit, Newfoundland

Technical – Economic Assessment of Centralized Processing of Base Metals in New Brunswick / Flotation–Pressure Leaching of Zinc Concentrates



Thibault & Associates Inc.

Applied Process Chemical Engineering

330 Alison Blvd
Fredericton, New Brunswick
Canada, E3C 0A9

Phone: (506) 454-2359

www.thibault-process-engineering.ca