

METALLURGICAL SERVICES FROM SGS

MINING SECTOR PERSPECTIVE

SGS Minerals Services offers a very broad range of value-added solutions, which reduce risk, enhance value and maximise returns at each step of the minerals value chain. Services range from the simplest quality and quantity inspection and testing for traded minerals, to complex flowsheet design and optimization of processes for the recovery of metals in plants. With a unique coverage of the minerals value chain and a truly global presence, SGS Minerals Services is the leading supplier of innovative, technologically-advanced services to help our clients achieve their goals.

SGS Minerals Services:

- develops and demonstrates sustainable flowsheets for metal and mineral extraction, and confirms processing techniques through bench and pilot plant programs
- performs geometallurgy and modeling projects
- offers expertise in geostatistics, orebody modeling, resource estimation, data processing, geotechnical engineering and hydrogeology
- offers process design and performance predicting models including FLEET® for flotation and CEET® for comminution
- performs on-site, in-plant commissioning, bench marking, auditing and troubleshooting services, as well as automated advanced process control and expert system installation
- provides leading-edge flotation equipment including flotation columns, contact cells and innovative gas injection spargers
- provides a range of comprehensive mineralogical services unique to the private sector
- provides testing and pilot plant services to the diamond and gem stone exploration sectors
- provides analyses for a full range of inorganic and organic materials in extensive analytical facilities
- offers environmental services ranging from wastewater treatment solutions, accredited analytical services, characterization of ores, mine products and wastes to tailings covers testing



MAJOR ACTIVITIES

The major activities of SGS Minerals Services include:

- process and flowsheet development for recovery and purification of pay metals
- geometallurgy programs featuring advanced geostatistical components
- on-site technical evaluations and audits
- evaluation and installation of advanced process control using expert systems
- development of new and innovative technologies for complex ore processing
- analytical and mineralogical support to late-stage exploration or development programs

- generation of engineering data for plant design purposes
- evaluation and stabilization of discharge streams and waste products

METALLURGICAL OPERATIONS

SGS Minerals Services' metallurgical operations conduct flowsheet development, bankable testing and in-plant services in the following areas:

Mineral Processing

Bench and pilot plant crushing and grinding services (autogenous, semi-autogenous, ball mill, rod-mill grinding, HPGR) circuit modeling and design optimization using CEET® and JK Simmet. Dense media separation, gravity, magnetic (high and low intensity, wet and dry electromagnetic and permanent magnetic) and electrostatic separation, size classification, thickening. Flotation (locked cycle and batch testing). Flotation circuit modeling using FLEET®, design, optimization and scale-up. Flotation cell dynamics. Upgrading of industrial minerals. Flocculation, reagent development, simple and complex pilot-plant testing. Process automation.



Hydrometallurgy

Atmospheric, biological and pressure leaching. Cyanide and other lixivants leaching of gold ores. Cyanide recovery and destruction processes. Metal purification and recovery processes such as SX, IX and EW. Rheology of tailings and ore slurries.

Geometallurgy

Sample selection. Variability testwork using standardized, low-cost tests that require a small sample volume. Related data collection and correlations. Addition of data into block model or mine plan. Geostatistical data handling. Process modeling.

In-Plant Services

Audits, troubleshooting, de-bottlenecking, development of process efficiencies, process control, metallurgical plant commissioning, on-site pilot plants, training, routine assistance.

Process Control and Information Management

Needs analyses. Design and implementation of expert systems through the use of MinnovEX Expert Technology (MET). Incorporation of control technology such as neural networks, generic algorithms and statistical process control (SPC). Instrumentation audits, selection, procurement, configuration and integration.



ANALYTICAL, MINERALOGICAL AND ENVIRONMENTAL OPERATIONS

SGS Minerals Services' analytical, mineralogical, and environmental groups offer testing and consulting services in support of metallurgical activities, and on a custom basis for external clients. With millions of determinations a year and prompt turn-around, our laboratories continue to meet and exceed our client's growing expectations in fields that include:

Analytical Services

Major, trace and precious element analysis in any media, rare earth element analysis at trace and ore levels. Sb, Hg, Se, As determinations. Mobile Metal Ion (MMI) geochemistry. Assays of metals in solutions, pulps, process waters and solvents, in support of material balance determinations. Gold and PGE analyses. Anion and cation speciation. Due diligence and check sample analyses, settlement and umpire assays. Complex organic analyses. Environmental analyses. Bacteriological analyses and identification. Occupational health analyses.



Mineralogy

High Definition Mineralogy (quantitative study of minerals using technologies such as QEMSCAN, X-ray diffraction analysis (XRD), image analysis and other automated techniques). Mineralogical identification, petrographic analysis and textural studies. Process mineralogy (predictive and ore mineralogy, liberation and deportment studies) and exploration mineralogy (petrographic descriptions). **EXPLOMIN™** (automated measurement of drill core mineralogy). Environmental mineralogy (waste rock studies, contaminant and tailings characterization). Mineral particle sizing and deportment. Mineral separation facilities (heavy liquids, gravity, magnetic, magnetic susceptibility).

Diamond Exploration Services

SGS Minerals Services offers a range of diamond exploration services commercial diamond recovery, and diamond grading and classification. Bulk sample processing is done by ore concentration in 1t/hr or 10t/hr dense media separation plants, followed by diamond recovery by grease tabling and SORTEX™. SGS Minerals meets all Kimberley Process protocols for the shipping of diamond-bearing materials.

Environmental Services

Treatment of acid mine drainage and heavy metals contaminated waste waters. High Density Sludge (HDS) technology. Decommissioning, acid rock drainage testing. Static and kinetic acid-base accounting testing. Sludge densification, leachate characterization (Reg. 347, EPA, BC, Quebec and ASTM protocols). Baseline environmental studies, physical properties testing (e.g. settling, compaction, plastic limits, consolidation).