W. Joseph Schlitt, PhD, PE, QP

Consulting Metallurgist

SUMMARY

Over 50 years of experience in process development, technology and project assessments, engineering, and plant-oriented studies for the worldwide mining industry. Primary emphasis has been on hydrometallurgy and chemical processing, particularly for copper and gold. Coverage has included heap, dump, vat, agitation, bio-, and in-situ leaching, plus metal value recovery by SX-EW, carbon adsorption, IX and cementation. Additional experience in leaching and recovering other metals. Also extensive work in comminution and flotation, pyrometallurgy and mining. Services include preparation of 43-101 compliant reports, operations improvements, testing for new mineral prospects, assessment of new technology, laboratory and pilot plant programs, due diligence assessments, legal assistance and contractor liaison. Experience is presented in reverse chronological order with most recent projects listed first.

CREDENTIALS

Ph.D., Metallurgy (1968); Pennsylvania State University
B.S., Metallurgical Engineering (1964); Carnegie Institute of Technology
Qualified Professional (QP) member of The Mining & Metallurgical Society of America (No. 01003QP, with specialty in metallurgy)
Registered Professional Engineer, Texas (No. 53603 – Metallurgical Engineering)
Patents: U.S. No. 3,723,598 for SO_2 removal
U.S. No. 4,152142 for smelter slag processing

EXPERIENCE

Metal Production by Leaching and/or Flotation

Part of a team doing a due diligence assessment of a copper leach operation for a confidential client. The metallurgical portion focused on secondary copper recovery from existing heaps, improved conventional leaching of newly mined material and in-situ leaching of an adjacent deposit where the copper mineralization is hosted in a porous sandstone formation.

Managed the metallurgical program on flotation of Co-Cu in a pyritic setting, together with processing options for the resulting Cu-Ag concentrate and the cobaltian pyrite flotation product. Prepared the metallurgical sections of 43-101 compliant resource assessments issued by the owner.

Served as a consultant to CS Mining in SW Utah. Initial activities were to help restart and improve a small milling and flotation operation recovering copper and silver. A separate program is also under way to recover the oxide copper from the final flotation tails using an agitated sulfuric acid leach with SX-EW. The work also included development of pre-float steps for recovery of a salable magnetite product and a review and validation of all metallurgical laboratory procedures and practices. Initial planning was done to evaluate a heap or dump leach for material below the mill cut-off grade. All programs were put on-hold when the company filed for bankruptcy.

Assisted Mine Development Associates with preparation of the metallurgical portions in a 43-101-compliant resource assessment for the World Beater gold property in Inyo County, CA.

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Recently served as the metallurgical QP for Red Eagle Mining Company (REM) on their Santa Rosa gold project in Colombia. Coordinated the metallurgical testwork and interpreted the results for multiple process options including direct cyanidation, milling and flotation of the ore and gravity concentration. Helped prepare multiple 43-101 reports on the project, which is now in full operation.

Retained by Compañia Minera Zafranal to assist with their Zafranal copper project by reviewing and interpreting bottle roll leach tests on various ore types from the deposit.

Teamed with AMEC to update the vat leach option for Marcobre's Mina Justa Project. Later provided additional consulting services directly to Marcobre. The main activities center on treatment of the overlaying oxide ore. Previously assisted GRD Minproc as leach consultant on the definitive 43-101 compliant feasibility study for the same project. Participated in design of an integrated testwork program involving bottle roll and column leach tests, which led to selection of a vat leach flowsheet for the project. Additional activities included in-depth reviews of the design and engineering packages for the SX-EW facilities.

Teamed with Ausenco to develop, manage and interpret the copper leach testwork program for the Aktogay copper project in Kazakhstan. This involved both smaller column tests for different process variables and confirmatory tests using large (multi-tonne), full height columns for each of the major ore types. An important consideration was the extreme cold at the site during the winter.

Was retained as consulting metallurgist by Peregrine Metals Ltd. for their Altar copper project in San Juan Province, Argentina. Originally managed the bio-leach portion of the Phase 1 testwork. Then managed Phases 2 and 3 of the metallurgical testwork, an integrated program covering flotation and copper heap leaching. This work supported issuance of a Preliminary Economic Assessment and an updated NI 43-101 report. A separate program was conducted to study recovery of gold from the leach cap and an adjacent epithermal quartz resource. Work on this project ended following Stillwater Mining's acquisition of the property.

Retained by Geologix Explorations, Inc. as metallurgical consultant. Prepared due diligence reports on potential acquisitions in Mexico. Managed the initial metallurgical testwork program for Tepal, a copper-gold porphyry deposit. The testing included milling and flotation for the sulfide resource. The program also involved cyanide leaching for gold recovery from the oxide cap, including use of SART technology to deal with the cyanide-soluble copper.

Participated in an in-depth internal review of Rio Tinto's La Granja project in Peru. The main focus was copper heap leaching and control of copper-bearing acid drainage from mine waste dumps.

Provided consulting services to Energy Resources of Australia, Ltd. for their Ranger uranium heap leach project. The main focus was on scale-up criteria for extrapolating test

data to the commercial operation. Proposed solution management practices were also reviewed. Several changes were recommended in both areas.

Assisted a confidential client with preparation of a due diligence study on acquisition of a polymetallic (Cu-Zn-Pb-Ag) deposit in Peru. Also conducted an operations improvement program on the client's existing copper leach/SX-EW operation in Arizona. Prepared scoping studies on use of cementation to recover copper at small leach operations in Armenia and Zambia.

Served as consultant to Kennecott Utah Copper on their project to design and install a small SX-EW facility at the Bingham Canyon mine. Construction of the plant was cancelled and a modern cementation facility was built instead.

Metallurgical consultant to Candente Resource Corp. for their Cañariaco copper deposit in Peru. Managed the bio-leach program, which included bottle roll and column leach tests, plus some special diagnostic testwork. Interpreted test results to select leach parameters.

Consulting metallurgist to Tethyan Copper Co. for their Tanjeel (Riko Diq) copper leach project in Pakistan. Consulting metallurgist to a confidential client for due diligence evaluations on three copper mine-to-leach properties (Chile, Mexico and U.S.A.) being considered for acquisition. The main areas reviewed were the metallurgical testwork, the proposed leach parameters and designs for the heap leach and SX-EW facilities.

Leach-SX-EW consultant to Rio Tinto for the technical evaluation of the Escondida sulfide run-of-mine (ROM) leach project. The main areas under review included the copper recovery, the design of the forced aeration system and the potential for heating the leach dump through pyrite oxidation.

Metallurgical consultant to Phelps Dodge for a detailed review of the proposed metallurgical parameters for leaching both the Dos Pobres and San Juan oxide ores in the Safford district. The parameters for the Dos Pobres ore body were confirmed, but Phelps Dodge was advised to do further testing on a representative sample of San Juan ore. Phelps Dodge has now developed the property.

Lead Technical Consultant on a detailed risk assessment of a potential run-of-mine (ROM) dump leach operation at Newmont's Batu Hijau mine in Indonesia. The main concern was the water balance associated with the heavy seasonal rains at the site, plus the potential impact this could have on the proposed SX-EW operation.

Lead Process Engineer for the Phelps Dodge 27 / 28 Dump Leach Expansion Project, including studies and engineering to increase the capacity of the Miami leach dump by more than 45 million tons. Trade-off studies included evaluation of four alternatives for PLS pumping systems.

Process Specialist for Ivanhoe Mines Ltd. and its operating subsidiary, Myanmar Ivanhoe Copper Company Limited. Responsible for assisting the present Sabetaung-Kyisintaung copper heap leach/SX-EW operation with improvements in appropriate plant areas and for providing conceptual engineering for the adjacent undeveloped Letpadaung deposit. Both projects are located in a typical tropical setting with distinct dry and monsoon seasons.

Process Specialist for the El Abra ROM leach project in Chile. The project involved a major on-site leach testing program and feasibility study to determine if the present heap leach system could be expanded to include low-grade run-of-mine ore. Any increase in production would utilize spare capacity in the SX-EW operation and have a low incremental cost. The project was implemented.

Lead Process Engineer on the leach/SX-EW portion of the Cerro Negro Project in Peru (65tpd cathode). Duties focused on interpretation of metallurgical test results and their extension to the design of the leach system, analyses of the optimum crush size and heap stacking alternatives, and details of the leach, SX-EW and process water systems.

Lead Process Engineer for Cobre Mining Company's planned Hanover Mountain Project in New Mexico, a 10-million stpy heap leach operation with 75 stpd of copper cathode output via SX-EW. The scope included evaluation of metallurgical test results and selection of commercial leach system parameters, analysis of conveying vs. trucking for crushed ore placement, and all details of SX, EW, and process water facilities. The project was never completed, as Phelps Dodge acquired the company.

Conducted an in-depth review of the Intec copper hydrometallurgical process.

Consulted on Hierro Mantua copper leach project in Cuba, the Sanyati poly-metallic heap leach operation (Cu, Co, Mn and Zn) in Zimbabwe, and the Erdenet copper dump leach project in Mongolia.

Project Engineer and Process Consultant on Kennecott Utah Copper's Bingham Canyon heap leach/SX-EW field test on refractory ore. Scope of the project included design of the 1500-kt ore heap, the leach solution distribution-collection system, the heap aeration system, and the SX-EW facilities. Provided ongoing technical support for the field tests and management of extensive parallel column leach programs conducted at a third-party laboratory and at Rio Tinto's corporate laboratory in Bundoora, Australia. Microbial activity was a significant factor in the leach process and was studied and optimized in both the test heap and columns.

Pressure Leach

Project Manager on a study of three process alternatives for treating molybdenite concentrates. All three use an autoclave for the initial oxidation step and carry through to production of chemical-grade molybdenum products. Rhenium is also recoverable as a byproduct. The work involved development of complete process packages and capital and operating cost estimates for each alternative.

Process Specialist for interim engineering and operability review for Kennecott Utah Copper Corporation's US$95 million Moly Oxide Project in Utah. The facility uses a novel hydrometallurgical process to treat molybdenite concentrate to produce high-quality technical-grade molybdic oxide. Aker Kvaerner's work included significant process and design engineering plus evaluation of testwork data, and development of capital and operating cost estimates. Project manager on further process modifications being pursued by a potential partner in the project. These were to produce ammonium di-molybdate and chemical-grade molybdic oxide, as well as the technical grade material.

Bio-Leach

Process/Project manager on a confidential project to develop a polymetallic bio-leach system at the demonstration plant level. The feed was a blend of various concentrator streams. The demonstration plant was to utilize parallel tank leaching and heap leaching on the same feed. Testing was done to compare the performance of the optimized leach circuits and select the approach to be used in the commercial facility. Work on the demonstration plant reached the final feasibility stage when one of the partners withdrew from the project. An earlier phase of the work focused on a pressure oxidation route for treating the concentrate.

Process Engineer on the first phase of the Newmont Gold bio-leach project. This involved design of the demonstration plant that successfully produced gold and set the design basis for the commercial plant. Consulted to the project during basic engineering of the full-sized plant in order to translate the results from the demonstration project into final design criteria and flowsheets.

Process Manager on Haib Copper Project in Namibia. Work focused on development, coordination, and evaluation of integrated hydrometallurgy program conducted at various third-party laboratories. Testing involved conventional bio-leaching of both whole ore (columns/heaps) and concentrate (stirred reactors). Attention was also give to Mintek's proprietary "BFIG" process in which bio-regeneration of the lixiviant takes place in one vessel and chemical leaching takes place in another, both operating under optimum conditions for their own sets of reactions. Project included development of conceptual flowsheets, designs, and cost estimates for heap leaching and roast leaching with SX-EW.

Owner's Engineer for Girilambone copper heap leach-SX-EW project in Australia, involved from initial column testing through plant start-up. Directed commercialization of the heap aeration system to stimulate bacterial activity and copper leaching.

Cyanide Technology

Program Manager to support Augment Technologies in developing the DuPont proprietary copper/gold cyanide technology. Specific applications included a copper/gold heap leach at Newcrest's Telfer operation in Australia, recovery of copper and cyanide from a Merrill-Crowe barrens stream at the Est Malarctic mine in Quebec, and recovery of copper and silver from Polish flotation tailings.

Arsenic

Experienced in two areas of arsenic metallurgy: (1) treatment of arsenic-bearing smelter flue dusts, and (2) treatment of refractory sulfide ores containing arsenopyrite and other arsenic sulfides.

Worked on the successful development of a hydrometallurgical route for treating flue dusts containing principally lead, copper, and arsenic at Kennecott. The process started with a sulfuric acid leach of the dusts in an autoclave operated under oxidizing conditions. Spent leach liquor was used to slurry the dusts being fed to the autoclave where copper and molybdenum were solubilized, while the arsenic was precipitated as an insoluble ferric arsenate. After liquid-solid separation, molybdenum was recovered as chemical grade

calcium molybdate via solvent extraction and precipitation with lime. Copper was recovered by cementation on iron for return to the smelter. Spent solution was then recycled to provide the source of iron to stabilize the arsenic.

Involved with several processes, both chemical and biological, for oxidizing refractory sulfidic and arsenical ores. In general, the objective in these processes has been to at least partially oxidize the sulfides and arsenides so that the copper and/or gold are more easily leached with commonly used lixiviants. A portion of this work has been done on the proprietary processes being developed by Newmont Mining Company and DuPont Specialty Chemicals.

Uranium

Manager of Technology participating in two in situ uranium projects in Wyoming. Also worked on the recovery of uranium from copper leach liquors using ion exchange, SX and precipitation of yellow cake.

Earlier Experience in Leaching and Other Technologies

Manager of Technology responsible for directing process engineers on numerous inorganic chemicals, minerals, and metals projects. Lead Process Engineer for feasibility study on Quebrada Blanca copper leaching project and for engineering study of seabed mining and processing cobaltiferous marine crusts. Manager for worldwide technology study of the barite and antimony industries; for numerous copper projects involving heap/dump leaching, cementation, ion exchange, and SX-EW; for projects to produce metallic salts; for study of sulfur recovery from gypsum; and for projects to reprocess spent petroleum catalysts. Participated in start-up of Mt. Gunson copper leach operation in Australia and consulted on bacterial leaching of copper.

Process Manager for major mineral project in South Africa, a prototype demonstration plant to chemically process phlogopite ore and produce cell grade alumina plus by-product potash and magnesia. Also involved with feasibility studies on the Dos Pobres and Cochise copper heap leach-SX-EW projects in Arizona, the Morenci Southside expansion, the Carmacks Copper Oxide heap leach project in northern Canada, and Sutter Gold's Lincoln mine project in California.

Principal Program Manager for coordinating work on Kennecott Minerals Company's exploration prospects progressing from core drilling to initial process selection and beyond, including mineralogical evaluation, studies on post-mine processing, initial process flowsheet development, and project feasibility assessments. Principal prospects included a Mexican silver property with a difficult-to-treat manganiferrous ore; two Nevada open-pit (low-grade) gold prospects—one well-oxidized and one sulfidic (pyritic); an underground vein-type (high-grade) prospect with base metal sulfides plus gold and silver; and a Duluth gabbro property (copper with nickel, cobalt, and silver-platinum by-products).

Directed all technical phases of Kennecott’s copper leaching activities, including development of improved solution management practices, forced aeration of heaps/dumps, and an in-depth study of mine waste haulage alternatives, including both material handling costs and recovery of copper from subsequent dump leaching operations. Provided liaison with the company's in-situ leach project in Arizona.

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EMPLOYMENT HISTORY

2005-	President, Hydrometal, Inc.
2004-2005	Independent Consulting Metallurgist
1994-2004	Aker Kvaerner (and predecessor firms)
1982-1994	Brown & Root
1968-1982	Kennecott Minerals Company