Abstract

In February 1993 Minproc Engineers Inc. successfully completed a lump sum contract to design, procure and construct a process facility for Empresa Minera Inti Raymi, S.A., at Kori Kollo, 42 kilometers from Oruro in central Bolivia. The operation treats 14,000 tpd of ore to produce 240,000 ounces of gold, and 1.4 million ounces of silver annually. The flowsheet consists of crushing, SAG/ball mill grinding, with carbon-in-leach for precious metal recovery.

The facilities were largely constructed with Bolivian based contractors with a minimum of field engineers from Minproc's home office in the United States. Other subcontractor supervisors came from Chile for the mill installations, and Australia for the electrical work. Most of the mechanical equipment was sourced from North America. The structural steel and platework came exclusively from Chile. The logistics of coordinating the transportation of equipment and materials over rugged terrain and assembling the plant are discussed.

Few significant problems arose during construction. Local shortages of construction materials were supplemented by supplies from other regions. Minor problems with the erection of some of the vendor-supplied equipment were quickly rectified on the site or at local machine shops with no adverse impact on the overall schedule.

Construction started in November 1991, and the plant performance trials were successfully completed in mid-February 1992, some 76 days ahead of the original schedule. The safety record was excellent, with only 1624 lost time hours occurring in a total of 1.5 million hours worked.
1 Introduction

1.1 General
The Kori Kollo operation is owned by Empresa Minera Inti Raymi S.A., a Bolivian mining company. Inti Raymi is an eighty-five percent owned subsidiary of Battle Mountain Gold Company (BMGC). The remainder of Inti Raymi is held by Zeland Mines S.A., a Bolivian mining company. The project is located near the village of La Joya, approximately 220 km south of La Paz, and 40 km north west of Oruro on the Bolivian altiplano. Inti Raymi started a heap leach operation in 1985. By 1988, following several expansions, 4,000 tonnes per day of oxide ore were being treated. At this time drilling was started to delineate the larger sulfide orebody. A feasibility study for the development of this deposit was completed in 1990, and following project approval, the engineering design was started later that year. During this period orders were placed for the major items of mechanical equipment. In July 1991, Minproc Engineers Inc. was awarded a firm price contract to design and construct the 14,000 tonne per day sulfide ore process facility.

1.2 Process Selection and Design
The precious metal mineralization at Kori Kollo is associated with pyrite veins, veinlets of disseminated pyrite and minor zones of tectonic and/or hydrothermal rocks. Sixty to 65 percent of the gold is associated with the veins, and the remainder with the disseminated pyrite. Petrographic studies have shown that the gold particles range from sub-micron to plus 100 microns in size, with approximately 30% smaller than 5 microns. An important feature of the ore is its high silver content, typically 8-10 times that of the gold.

Although the Kori Kollo ore is partially refractory, BMGC decided to treat it by conventional grinding and cyanidation, offsetting the value of gold lost against the savings in capital and operating costs realized by not including an oxidation process in the flowsheet. Primary crushing of run-of-mine ore is followed by a coarse ore stockpile, grinding and classification in an open circuit SAG mill and two parallel, closed circuit ball mills, cyanide leaching and precious metals adsorption onto carbon, carbon desorption, leach tailings thickening for water recovery, and disposal in an impoundment. Figure 1 is a simplified flowsheet representing the process.

The physical and operating parameters presented to Minproc as the basis for the plant design are outlined in Table 1. Table 2 summarizes the design criteria developed for the carbon circuit.