

## PRE-TREATMENT OF A REFRACTORY GOLD SULFIDE ORE BY MEANS OF ACIDITHIOBACILLI CELLS

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**Abstract**—Cyanidation is a relatively simple and cheap technology to treat gold-containing ores. However, this process is not completely effective in refractory gold-bearing sulfide ores. In the case of very low-grade ores, biooxidation is an attractive alternative pre-treatment to render the gold amenable to extraction. This process utilizes the ability of acidophilic bacteria to oxidize the sulfide matrix, physically freeing the gold. The aim of this work is to evaluate the recovery of other available metals (Fe, Mn, Cu and Zn) during the biooxidation pre-treatment of an ore from Andacollo with low gold recovery (less than 50 %). This pre-treatment was carried out in shaken flasks using pure cultures of *Acidithiobacillus ferrooxidans* and *Acidithiobacillus thiooxidans* and a mixed culture with both bacteria.

**Keywords**— *Acidithiobacillus ferrooxidans*, *Acidithiobacillus thiooxidans*, metal recovery, biooxidation.

### I. INTRODUCTION

The autotrophic bacteria *Acidithiobacillus ferrooxidans* (*A. ferrooxidans*) and *Acidithiobacillus thiooxidans* (*A. thiooxidans*) are frequently associated with sulfide minerals (Rawlings, 1997; Kelly and Wood, 2000). Both bacteria obtain their energy from the oxidation of reduced sulfur compounds. The major difference between those species is fundamentally that *A. ferrooxidans* is also capable of oxidizing iron(II).

These bacteria are capable of acting directly or indirectly on metallic sulfides, oxidizing the sulfides till sulfate and thus leaching the metals if the respective sulfates are soluble. For this reason, these microorganisms have been used for bioleaching of low-grade ore on a commercial scale (Donati *et al.*, 1992; Donati *et al.*, 1996).

Other recent application of these microorganisms is in the pre-treatment of gold ores in order to increase the subsequent gold recovery during cyanidation processes. In several gold ores, gold is trapped in the matrix of metallic sulfides, mainly pyrite (FeS<sub>2</sub>) and arsenopyrite (FeAsS). In such cases, ore must be pre-treated in order to release the gold physically and to make the ore amenable to cyanidation. The traditional methods of pre-treatment include oxidation by nitric acid, roasting or pressure oxidation. Roasting produces off-gases containing sulfur dioxide and arsenic trioxide, which requires later expensive treatment. The other methods require high pressure, high temperature and/or corrosion-resistant materials. Biological oxidation (biooxidation) as pre-treatment of refractory gold ores is based on the ability of acidophilic microorganisms to oxidize and dissolve pyrite and arsenopyrite, thus releasing the entrapped gold particles (Longhans *et al.*, 1995; Komnitsas and Pooley, 1989). Although the rate is low, biooxidation is considered to be cheaper (specially in very low-grade ores) and more environmentally friendly than other methods (Poulin and Lawrence, 1996; Deng *et al.*, 2000; Climo *et al.*, 2000; Ubaldini *et al.*, 2000; Karamanev *et al.*, 2001). During the biooxidation process, other available metals can be recovered, thus avoiding overconsumption of cyanide (due to the presence of cyanicides like iron or zinc). At the same time, this process avoids the possible coating of gold particles with precipitates (specially iron hydroxides) during the cyanidation under alkaline conditions.

Andacollo is a gold sulfide ore coming from Andacollo area in the northwest of Neuquén province (Argentina). Gold is present in that ore as submicroscopic particles contained in a pyrite matrix. This ore is partially refractory (about 50 % of the gold was extracted even without pre-