Journal Comment

Percolation leaching

'Nature provides a free lunch,
but only if we control our appetites'
William Ruckelshaus
Business Week, 18 June 1990

Six of the papers in this issue are from an international conference on a topic that many consider as one of the most important in future extraction metallurgy. It deserves its more exotic name of 'percolation leaching' rather than the previous names of dump or heap leaching, which suggest that the technology is best suited for treatment of waste materials. In fact it relates to the approaching inevitable necessity of treating low-grade and widely dispersed ores once the high-grade resources have been depleted.

The six papers presented might, at first sight, appear to be only a small window on such an important topic. But I found all of them fascinating and thought–provoking.

I would recommend the non-specialist reader to start on the process for treating the Talvivaara deposits, located in eastern Finland, which comprise one of the largest sulphide nickel resources in the world with 1121 million tons in measured and indicated resource categories. The Talvivaara ore defied attempts to recover the valuable constituents until a greater comprehension of the possibilities of micro-biological leaching on a commercial scale had become evident at the end of the last century. The commercial success of the Talvivaara operation is considered as a hall-mark achievement, to lead into the 21st century. The paper gives a good idea of the immense size, nature and time scale involved, in projects utilizing micro-organisms as the key to success. Thiobacillus ferrooxidans, the most common of them, was first used for bioleaching for recovery of gold from refractory ores in South Africa 35 years ago.

My second suggestion for compulsory reading is the paper from Mintek on the leaching of copper sulphides. This illustrates that percolation leaching is a lot more complex than indicated by the Talvivaara success. Chalcopyrite requires a higher temperature than the other base-metal minerals, so that temperatures of around 50°C have to be maintained in the piles of material to be leached. This requires the heat of the oxidation of the iron sulphides to be utilized and much more careful control of the heat balance and aeration of the piles of rock being leached, to the extent that Mintek has developed computer algorithms to assist operators to maintain temperatures and oxidative leaching through the many channels in the heaps using data from laboratory simulations. In addition, one has to ensure that colonies of micro-organisms, active at high temperature, are chosen and maintained.

The final result leads to one of the most complex operating procedures I have encountered. I am sure the Mintek computer programs and instrumentation will be much in demand since the copper ores represent about 70 per cent of the anticipated candidates for percolation leaching.

The complexity of percolation leaching in practice is confirmed in a paper by J.F. Lupo of Newmont Mining Corporation. Although the paper deals with sustainability, the focus is on issues affecting metal and solution recovery, solution flow and containment, and stability of the ore heap. There are many other aspects mentioned, including variations in mineralogy, geotechnical considerations, and environmental factors. Frightening, but compulsory reading if one is contemplating the use of percolation leaching.

Perhaps I should add some more complexities, of which I am sure the authors are aware, but might welcome some different or additional insight for planning future R&D projects.

The first relates to rock mechanics, the topic of my most recent Comment in August where I refer to rock cleavage in relation to the exposure of the mineral species. This is exactly the characteristic most important to almost all types of leaching. This can be influenced by the blasting methods, which can be varied in open pit-mining, which is commonplace in conjunction with percolation leaching. It is a variable that cannot be ignored, not only as regards the mine call factor but also the hydraulic performance of the heap.

The second point is the observation that the treatment of waste and recycle solutions, which are likely to contain finely divided solids released after dissolution of soluble minerals or precipitated after neutralization or recycle of solutions, can greatly affect sustainability. The treatment of such solutions is made much easier by the advent of ion exchange equipment that can operate in a mixed bed, or countercurrent multistage mode with resin-in-pulp characteristics. Such equipment can also be used to precipitate hydrates of metals at different pH values without adding foreign ions.

The review of the microbiological aspects of bioleaching by Mariekie Gericke of Mintek is comprehensive and provides as good a background for the non-specialist as I have encountered. Interestingly, there appears to be merit in looking for new combinations of micro-organisms for faster bio-reactions and also attempting to isolate new species existing in nature with greater reactivity and stability at higher temperatures.

To make sure that the message gets across that percolation leaching of copper (and many other metals) is not dependent only on biological reactions, there is a paper by Cassiday and Associates on their SART process. This well-researched process recovers copper cyanide as a precipitate after cyanide leaching. This can be of benefit in those gold- and copper-bearing ores where the copper can interfere in the carbon-in-pulp recovery of the gold.

Journal Comment (continued)

There are many micro-organisms and other reagents that can be used in a percolation heap mode. This is particularly the case in southern Africa and our neighbours in Madagascar. The new Ambatovy nickel deposit is claimed to be among the largest in the world. There are unquestionably many multifaceted R&D opportunities forthcoming. The three additional papers in this issue from Iran and Turkey on aspects of open-pit mining are of relevance.

For this reason it might be appropriate to make some comment on the extensive consideration given to the patent and intellectual property rights by R.F. Taberer.

His contribution is intriguing in the legal complexities and ambiguities around the question of whether patent rights on a micro-organism can be claimed.

After some 60 years in technical research I have come to the conclusion that the easiest way to waste money is to exclusively back single innovative intellectual hunches. In the mining industry, a highly erudite statistical technique has evolved to assess probabilities of multiple sequential events. The most promising way to achieve economic success is the portfolio concept, in which one undertakes many alternative approaches to solving a problem or developing a mineral resource. One successful outcome usually pays for the several failures. Thus in planning major new developments one has to initiate many options.

For a country with a small science base, it is necessary to invite many participants, local or international, to collaborate in a joint portfolio effort and to contribute to costs and to share in final benefits. There are many resources in South Africa where a national portfolio approach is called for. Black Mountain, Gamsberg, Nkomati, and Barbrook are key words to mention, as well as many waste dumps of coal, gold, and copper, where multiple international options are possible. Severe confidentiality restrictions become necessary if one wishes to patent and impose royalties on every innovative suggestion, and this can discourage portfolio collaboration. Over-zealous patent legislation can do great harm to university research activities on an international front.

To attempt to make millions out of the improbability of discovering the 'super bug' that nature has taken many millions of years to perfect is symptomatic of an unhealthy greedy appetite.

In this issue, the award of bursaries to two mining undergraduates, Lindiwe Nyalunga of Wits University and Hlulisani Mabege of the University of Pretoria, is announced by Mining Indaba™, emphasizing the international collaborative goodwill that pervades the global industry. ◆

R.E. Robinson

Meeting of International Mining and Metallurgical Societies

A meeting of several leading international mining and metallurgical societies was held in conjunction with the MINExpo International exhibition in Las Vegas, Nevada on 23 September 2012. The meeting was attended by representatives of AusIMM (Australasian Institute of Mining and Metallurgy), CIM (Canadian Institute of Mining, Metallurgy and Petroleum), SAIMM (Southern African Institute of Mining and Metallurgy), and SME (Society for Mining, Metallurgy, and Exploration). This meeting was the second of a series initially hosted on the first November 2011 by IOM3 (Institute of Materials, Minerals and Mining) in London. The aim of the meeting was to foster cooperation between the various organizations, to discuss opportunities for improving and sharing benefits to members, and to benchmark the institutions against each other. Discussions were held about the state of the mining industry in the various countries, as well as the structure and strategies of the societies represented. There was broad agreement that the societies would offer services to each other's members at member rates. Calendars of events will be circulated between the organizations to minimize clashes. The next meeting in the series is planned for 29 September 2013, to coincide with the World Gold conference in Brisbane.

From left to right: Bob Schafer (President Elect, CIM), Jean Vavrek (Executive Director, CIM), Jessica Kogel (President Elect, SME), Dave Kanagy (Executive Director, SME), Alice Clark (President, AusIMM), Drew Meyer (President, SME), Michael Catchpole (Chief Executive, AusIMM), Rodney Jones (Vice President, SAIMM)