From P.J.D. Lloyd*

A comment on the paper 'A Mintek perspective of the past 25 years in mineral bioleaching'

by M. Gericke, J.W. Neale, and P.J. van Staden, Published in the Mintek 75th Anniversary edition October 2009

Gericke, Neale and van Staden give an excellent overview of the bioleaching field and how it has evolved. However, they have overlooked a South African development that preceded the 1980 Chilean experience, the earliest engineered bioleaching they record, by more than a decade.

In the mid-1960s, the Physical Sciences Laboratory of the Chamber of Mines initiated studies of bioleaching of uranium on slimes dams. Initial laboratory studies[1] identified *Thiobacillus ferrooxidans* and similar related species as being responsible for the rapid oxidation of pyrite, with the formation of ferric iron and sulphuric acid, once the natural pH of the slimes had fallen to below pH5. The mixture of ferric iron and sulphuric acid was known to be a good lixiviant for uranium. This work was reported at a National Institute for Metallurgy symposium, and the National Institute for Metallurgy was, of course, a predecessor of Mintek.

The laboratory study was extended to investigate the role of micronutrients in fostering the growth of the bacteria. This led to three findings:

- There was sufficient phosphate in the oxidized slimes.
- There was no need to supplement the nitrogen supply because the *Thiobacilli* were shown to be nitrogen-fixing, a novel finding later confirmed by work at the British microbiological institute at Porton Downs.
- There was adequate potassium available.

Pilot tests showed that uranium could be recovered from the bacterially oxidized slime by washing and ion exchange. A 2 ha site was established at East Geduld, where the slime, once oxidized, was mined to a depth of 10 cm once a month, and the material treated for the recovery of uranium at a rate of $120 t.d^{-1}$.

There were several important findings[2,3]:

- The rate of mining of 10 cm/month was the maximum that could be maintained. A greater rate led to lesser dissolution of uranium. There was minimal increase in the fraction of uranium solubilized at a lower rate of mining.
- >90% of the uranium was leached, but it did not necessarily report to the mined material. During the wet summer months, the solubilized uranium was driven deeper into the dam. However, during the dry winter months it returned to the surface layers and could be recovered from the mined material. The concentration in this enriched layer was about twice what it would have been had no displacement taken place. Thus, for most of the summer, the material that was mined was waste, but in winter the feed to the recovery plant was about twice the natural concentration.
- The source of the air needed for bacterial action within the slimes was the 'breathing' of the slimes dam as the atmospheric pressure varied and as the temperature in the upper layers of the dam changed from night to day.

The work was supported by the Nuclear Fuels Corporation of SA (NUFCOR). The economics were very positive at a uranium price of >$5/lb, but the process never entered commercial use because the demand for uranium slumped in the early 1970s, and there was no need for an extra source of supply over and above that which was being produced conventionally.

The references are not readily accessible, but an overview was published by the AIME in 1980[4] which can still be found. Much of the detail can also be found in the 1978 CMMC proceedings[5].

I believe this contribution to the historical record needs to be acknowledged. South Africa was testing bioleaching on an industrial scale well in advance of the rest of the world.

References

1 LLOYD, P.J.D. The bacterial treatment of sulphide minerals. *Proc. SA Chemical Institute and National Institute for Metallurgy Symposium on Chemistry of Extraction Metallurgy,* NIM, October 1967.

2. LLOYD, P.J.D. Economic recovery of low grade uranium values from Witwatersrand ores, *Proc. Conf. Recovery of Uranium,* Sao Paulo, Brazil, IAEA-SM-135/31, IAEA Vienna, 1970. pp. 437–454.

3. MROST, M. and LLOYD, P.J.D. Bacterial oxidation of Witwatersrand slimes, *Proc. Conf. Recovery of Uranium,* Sao Paulo, Brazil, IAEA-SM-135/32, IAEA Vienna 1970. pp. 223–239.

4. LLOYD, P.J.D. Ninety years' experience in the preservation of uranium ore dumps, *1st Int Conf Uranium Mine Waste Disposal*, Vancouver, AIME New York 1980. pp. 33–42.

5. LLOYD, P.J.D. Potential of integrated mining and extraction systems on the Witwatersrand, *Proc 11th CMM Congress,* Hong Kong, May 1978, IMM London, 1978, paper no. 71. ◆

* *Industrial & Petrochemical Consultants (Pty) Ltd, South Africa*

ISSN 0038–223X/3.00 + 0.00. Letter to the editor, dated November 2009.