

12 April 2002

International Institute for Environment and Development
Mining, Minerals and Sustainable Development Project
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Dear Colleagues,

I would like to congratulate your group for the excellent MMSD Draft Report, and to respond to your invitation for comments by offering the following information for your consideration in revising this draft.

In Chapter 10, "Mining, Minerals and the Environment", your discussion on the topic of managing metals in the environment (pp 10-10 ff) correctly notes that the traditional option of using lime involves high costs and constant maintenance and attention. With that thought in mind, I would like to bring to your attention an alternative method that has been proven to offer a cost-effective and permanent way to deal with contaminated water and soils arising from mining. The process was developed over a period of many years at Southern Cross University in Australia, and is being marketed world-wide by Virotec International Ltd.

Virotec International Ltd is a shareholder-owned company, listed on the Australian Stock Exchange and the London Stock Exchange AIM. The corporate website is www.virotec.com where considerable information about the company and its patented Bauxsol™ technology is available for your review. The process involves the application of residues arising from the Bayer process of alumina production, and has been widely reported in refereed technical publications. I will provide literature references if you wish.

Attached to this covering letter is a brief discussion of Bauxsol™ technology and some information about the commercial applications of this important new approach to dealing with acidic wastes contaminated with metals. I hope that you find this information to be of interest, and would be pleased to provide any further information that you may require.

Yours sincerely,

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1. Introduction

Virotec International Ltd is an Australia public company developing the science of environmental geochemistry and commercialising geochemical technologies for cleaner land and water. The company is listed on the Australian Stock Exchange and the Alternate Investment Market of the London Stock exchange.

2. Bauxsol™ Technology

2.1. Description

The Bauxsol™ Technology provides a range of commercial products and processes that combine to neutralise acid and to trap and bind trace metals and some other chemical substances.

The Bauxsol™ Technology range of products is based on a complex mix of iron and aluminium-oxyhydroxides, and several carbonates, hydroxides and hydroxy-carbonates. Consisting of predominantly fine particles (with a high surface area/volume ratio and a high charge/mass ratio) these products allow difficult and toxic metals to seek out their least soluble (least mobile) compound. The products consist of dry red solid grains composed of a complex cocktail of naturally occurring inorganic mineral compounds.

The range of products has high acid neutralising capacity (2.5 - 7.5 moles of acid/kg, depending on the product) and very high trace metal trapping capacity. Despite their high acid neutralising capacity, the products all have a near-neutral reaction pH (typically between 8.2 and 8.6).

2.2. Main Environmental/Safety Benefits

The products sequester over 99.99% of all heavy metals from water and soils. Its acid neutralisation capacity is also high, due to the abundance of amorphous and finely crystalline mineral phases that form weak bases. As Bauxsol™ is buffered at a pH of 8.6 there is no risk of exceeding the environmental guideline upper limit of pH 9.0, even with inadvertent over-dosing.

The residue after treatment of water bodies is safe and Toxicity Characteristic Leaching Procedure (TCLP) tests or leaching with acidic solutions buffered at a pH of about 3 are able to remove only a small proportion of the bound metals

In soil, the grains simply remain where they are. Even after treatment, the grains are permanently inert and pose no threat to the environment.

2.3. How Bauxsol™ is applied

Virotec's treatment process is simple. Fine-grained Bauxsol is added to metals-laden wastewater or soil. The Bauxsol triggers a chemical reaction with the heavy metal contaminants (because of its binding mechanism) and the heavy metals are sequestered within the fine Bauxsol particles as insoluble minerals. At the same time, the Bauxsol grains neutralise any acid in the soil or water.

There is no apparent chemical limitation on the size of the acidic metal-rich water body that can be treated. The treatment involves directly adding product(s) to the dammed water. The products can be dispersed into the dam using any conventional means and usually by existing infrastructure on site. The duration of the treatment, the selection of the product or products to be used, the intervals between applications of the various products will be determined by the degree of contamination and the size of the dam. Based on a case study in Australia a 1,5000 megalitre tailings dam can usually be treated to strict environmental release standards in less than three months.

After treatment, suspended particles in the water in the dam quickly settle to form a thin layer of sediment typically less than 5mm thick. The extracted metals remain locked in the exhausted Bauxsol™ sediment covering the tailings.

2.4. Effect of Using the Bauxsol™ Technology

Bauxsol Technology provides an effective alternative to existing methods for treating ponded AMD/ARD water to the high standards required for the protection of aquatic ecosystems or to the less stringent drinking water, stock watering or irrigation water standards as required. Refer Table 1 for the results of the treatment of a 1,500 ML Tailings dam.

The Technology allows for treated water to be safely discharged into the environment, thus obviating the need for indefinite storage of contaminated water. This will significantly reduce the environment threat of large bodies of contaminated water currently being retained in large Tailings Dams.

Table 1 - EFFECT OF TREATING AMD WATER IN THE 1,500 ML TAILINGS DAM

Component	Before treatment	After treatment
pH	5.2	7.3
Aluminium (µg/L)	1,060	13
Cadmium (µg/L)	310	<1
Copper (µg/L)	1,510	3
Iron (µg/L)	230	29
Lead (µg/L)	16	<0.1
Nickel (µg/L)	145	12
Zinc (µg/L)	11,570	39

The sediment remaining after the treated water is discharged is able to be easily revegetated and will support healthy plant growth. Therefore it is expected that there is no added requirement to treat or dispose of this sediment.

The Bauxsol Technology can also be used to prevent acid and trace metal release from sulphidic mine tailings, sulphidic waste rock and acid sulphate soils, which effectively prevents acid mine drainage from occurring. This allows for effective closure plans to be adopted for mines, ensuring the impact of mining in the future has less negative environmental impact.

2.5. Economics

An advantage of this process is that the treatment can occur in situ and there is no requirement to invest significant amounts of capital in treatment and process plants.

The overall cost associated with using the process for any site is affected by the quantity of each product required for the treatment, which depends on the level of contaminants and the quantity of water, and the location of the site, relative to the production facility. It is expected that most water bodies can be treated in the price range of \$US1,000 to \$US2,000 per megalitre. However specific costing is required on a job-by-job basis.

2.6. Example Sites

The Technology has been applied to: -

- Mt Carrington site (northern NSW Australia) toe dam of 1,500,000 litres.
- Mt Carrington site (northern NSW Australia) tailings dam of 1,500 megalitres
- Gladstone Port Authority – treatment of sulphidic marine sediments
- Gold Mine - Baia Mare Romania, treatment of 3,000,000 litres of Acid Mine drainage (demonstration)

- Gold Mine - Baia Mare Romania, treatment of process water (demonstration)

The results for each of these applications are available.

2.7. Reference Literature

The Technology is covered by a patent (pending) titled “Processes and Compositions for Water Treatment”.

Reports have been prepared on the use of the Technology for water samples from a number of sites and applications. These include: -

- Neutralisation of Cyprus Acid Mine Water with BauxsolTM
- Savage river report on AMD (Tasmania Australia)
- Proposal for Treatment of Contaminated Water at the Cracow Mine site (Queensland Australia)
- Treatment of Federation Pit Water (Queensland Australia)
- Treatment of Acid Sulphate Soils at Emerald Lakes (Queensland Australia)
- Report on Bauxsol Testwork at Kidston Gold Mine (Queensland Australia)
- Report on Bauxsol Testwork at the Highway Reward Mine (Queensland Australia)
- Preliminary Data and discussion of the Berkeley Pit Water (Montana USA)