A COMMERCIAL APPLICATION
OF VIROMINE™ TECHNOLOGY

CASE STUDY: ACID MINE DRAINAGE, BAIA MARE, ROMANIA

"The data show that the water was treated successfully in five days and that 11 days after treatment commenced water quality met the standards set by the Romanian government..."

Water contaminated by AMD – before and after ViroMine™ Technology treatment

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PROBLEM

A legacy of long-term mining in the Baia Mare region is the formation of extensive Acid Mine Drainage (AMD) plumes flowing from the hills. AMD discharges into the local rivers of Baia Mare may be as high as 12,000 litres per hour and many highly visible AMD plumes run through the centre of Baia Mare (Figures 1-3) from the surrounding hills.

Existing technology used to treat AMD plumes from operating underground mines includes neutralisation with lime, but this treatment has proven to be ineffective and involves significant capital costs to implement. Lime treatment does not result in complete long-term removal of metals in acid water from the environment and the large quantities of unstable sludge that are produced are difficult to manage.

Figures 1-3. Photos of local rivers and streams polluted with uncontrolled AMD plumes from historic and operational mines in the Baia Mare region.

VIROTEC TOTAL SOLUTION

Virotec International successfully treated 2 ML of AMD at Baia Mare using ViroMine™ Technology. Acid B Extra™ reagent, was applied using an in-situ aerial application treatment technique. After initial water samples were analysed (Figure 4 & 5), Virotec was able to deliver an environ-mentally sustainable and economically viable solution to treat AMD water so that it could be discharged into the environment meeting Romanian Ecosystem discharge requirements.

The Acid B Extra™ reagent neutralised acidity in the water and bound metals in non-bioavailable, chemically inert forms without producing the large volumes of unstable sludge typically associated with lime-based treatments. The sediment produced using ViroMine™ Technology has a low volume and is chemically stable.

BACKGROUND

AMD is associated with the weathering and oxidation of pyrite and other sulphide minerals. AMD commonly has pH values below 3.0 and is enriched in Al, As, Cd, Co, Cu, Fe, Hg, Mn, Ni, Pb, SO_4, Zn and sometimes other metals (Rogers et al., 1998; Nordstrom & Alpers, 1999). Iron and sulphur oxidising bacteria, especially thiobacillus ferrooxidans, and dissolved ferric iron can increase reaction rates at low pH by up to six orders of magnitude (Rybicka, 1996) and accelerate the release of metals and acidity from soil, waste rock and tailings.

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Figure 4 & 5. These concrete channels were the input to the lime treatment plant in Baia Mare. Two mega litres of AMD water was transferred from this plant to a containment dam that was used to test the Acid B Extra™ reagent.

release of metals and acidity from soil, waste rock and tailings.

AMD is not just the result of oxidation of pyrite or other sulphide minerals in the presence of air and water but involves complex interactions between chemical, physical and biological processes (Karczewska, 1999). Under highly acidic conditions, metal ions including Al, As, Cd, Co, Cu, Fe, Hg, Mn, Ni, Pb, and Zn may be released from sulphide minerals and leached from other minerals in the waste rock, tailings and exposed pit walls in concentrations that can be toxic to terrestrial and aquatic plants and animals. Acidification can also influence toxicity as well as metal concentration through its influence on metal speciation. The direct effect of acidity on plants is the inactivation of most enzyme systems and the restriction of respiration and root uptake of mineral salts and water.

AMD control and treatment is the highest remediation priority for the international mining community. The scope of the worldwide AMD problem is highlighted by the situation in the United States. Nordstrom and Alpers (1999) estimated that 19,300 km of rivers and streams and more than 180,000 acres of lakes and reservoirs were affected by AMD in the US. In 1997, heavy metal contamination contributed to 65 percent of superfund sites and by 1999 there were 1206 metal contaminated sites on the USA Superfund National Priority List (Pierzynski, 1999).

Another local river in Baia Mare suffering from AMD.

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Figure 6. This pond was constructed to conduct the Acid B Extra™ reagent AMD treatments in Baia Mare. The pond was lined with geosynthetic liners and contained 2 ML of water.

TREATMENT METHODS

After initial characterisation of the AMD, Virotec's production technicians optimised the treatment and found that the Acid B Extra™ reagent was the most appropriate reagent to treat the contaminated water. A volume of 2 ML was transferred to a lined containment pond (Figure 6) for treatment.

As shown in Figure 7, the water was treated over five days using an in-situ aerial application technique. This application method can be used on small dams, but also has been used successfully on large dams such as the 14 ha surface area dam at Mt Carrington in Australia. The engineering and plant requirement to implement this treatment technique is very simple and can be constructed from machinery available at most mine sites.

Figure 7. Application of Acid B Extra™ reagent.

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RESULTS

Table 1 shows the initial and final characterisation of the Baia Mare AMD water. The water samples were analysed at a Romanian Government laboratory. The data show that the water was treated successfully in five days and that 11 days after treatment commenced water quality met the standards set by the Romanian government for all metals other than Mn. The water also passed the stringent Australian ANZECC standards for ecosystem discharge for all metals other than Fe. The results also show that concentrations of sulphate and other salts can also be reduced in AMD water.

TABLE 1. TABLE OF RESULTS OF BAIA MARE AMD WATER BEFORE AND AFTER TREATMENT. WATER WAS SAMPLED FOR ANALYSIS 11 DAYS AFTER TREATMENT COMMENCED.

	AMD before treatment	AMD after treatment using Acid B Extra™ reagent (Romanian Govt Lab)	Romanian Ecosystem Discharge Limits	Australian Ecosystem Discharge Limits
pH	2.6	8.6	6.5-8.5	6.5-9
Al	109	<0.05	8.00	0.1
As	0.00	NA	0.05	0.05
Cd	0.02	<0.05	0.10	0.002
Cu	0.05	0.09	0.10	0.005
Fe	91	1.81	5.00	1.000
Pb	0.03	<0.05	0.20	0.005
Mn	168	6.49	1.00	No Limit
Ni	0.26	0.06	0.1	0.15
Zn	26	0.15	0.5	0.005
SO_4	5090	1692	NA	NA
Na	80	538	NA	NA
K	22	21	NA	NA
Ca	323	286	NA	NA
Mg	35	8	NA	NA

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CONCLUSION

This application showed that ViroMine™ Technology, using the Acid B Extra™ reagent, is a superior technique to traditional treatments for removing metals and neutralising acid in AMD water. The technology also proved to be a fast solution for treating such water – meeting regulatory standards, and producing a quality of water 100 times cleaner than drinking water in respect to trace metals.

The treatment technique used by Virotec was easy to set up and operate – and quickly achieved targets thereby offering the customer substantial savings in capital costs associated with other treatment technologies.

Furthermore, no unstable sludge was produced and sediment from the application of ViroMine™ Technology can be reused as an effective soil conditioner to assist revegetation programs.

Water contaminated by AMD before and after ViroMine™ Technology treatment.

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