Ozone and Microorganisms Applied to Mitigation of Acid Drainage Formation in Coal Mining Tailings

Ozônio e Microrganismos Aplicados à Mitigação da Formação de Drenagem Ácida em Rejeitos de Mineração de Carvão

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Presentation summary

- *Introduction*
- *Objectives*
- *Methodology*
- *Results*
- *Conclusion*

Introduction

Acid Mine Drainage (AMD)

Iron-oxidizing bacteria

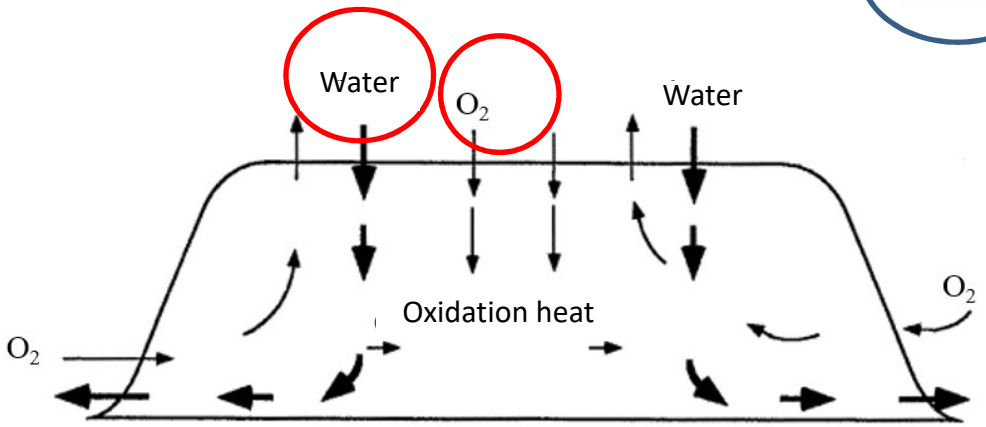

Figure 1: Conceptualization of AMD formation in a tailings pile.

Exposure of sulphide minerals to air and water: Pyrite Example (FeS_2)

$$4\,FeS_2 + 15\,O_2 + 14\,H_2O \rightarrow 4\,Fe(OH)_3 + 8\,H_2SO_4$$

Iron-oxidizing bacteria

Sulfate-reducing bacteria

Introduction

It is estimated 150 years to fully oxidize the pyrite content of a tailings pile that initially contains 2% pyrite (Ritchie, 1994).

(A) (B)

Figure 2: Environmental impacts generated by AMD: Sangão River (A) and tailings from coal mining/processing exposed to the environment in Criciúma-SC (B).

RITCHIE, A.I.M.. Sulfide oxidation mechanisms: Controls and rates of oxygen transport, in Jambor, J.L., and Blowes, D.W., Eds., Short course Handbook on Environmental Geochemistry of Sulfide Mine-Wastes: Mineralogical Association of Canada, 22: 201-246, 1994.

Objectives

Evaluation of *in situ* chemical oxidation of coal mining tailing to mitigate the generation of AMD using ozone.

→ The choice of ozone is due to its characteristic of being a strong oxidizer that leaves no residue when it decomposes during treatment.

Study of the effect of microbiological presence in coal mining tailings to provide the relationship between microorganisms capable of accelerating or decrease the generation of AMD.

Methodology

Lysimeter Experiment

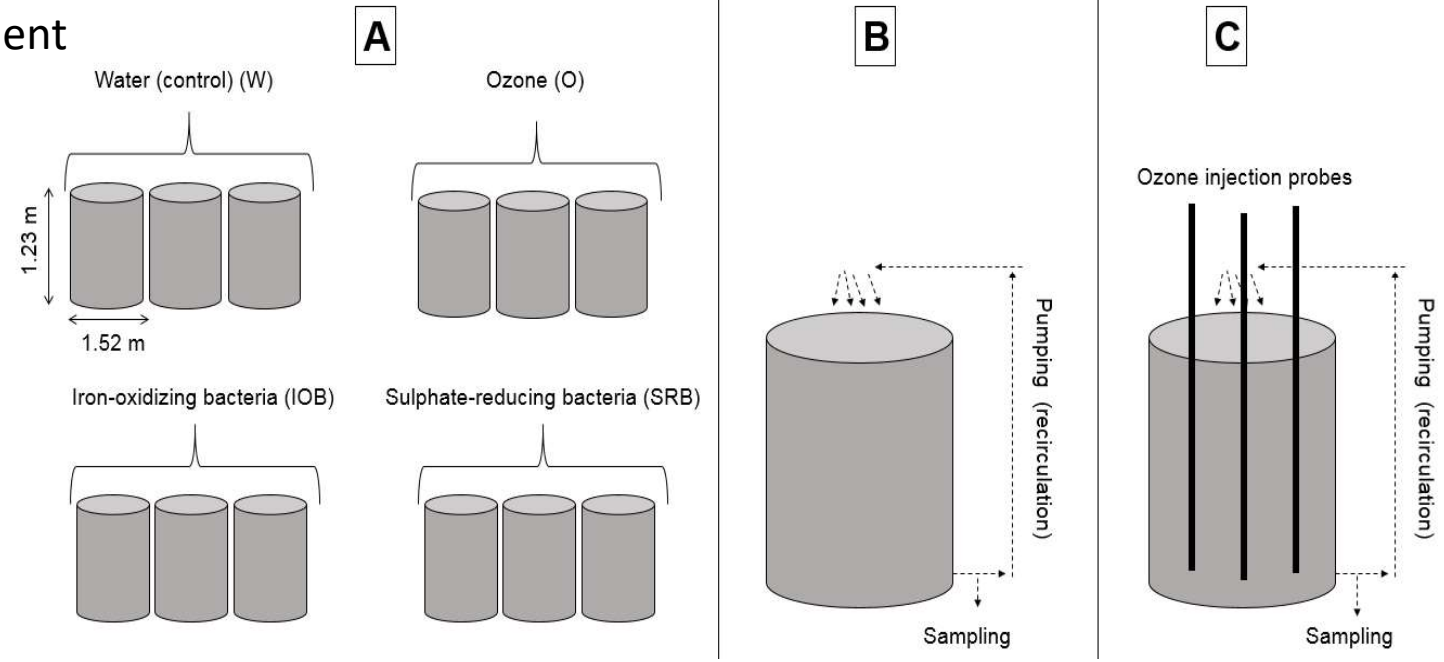

Figure 3: Experimental design (A), details of recirculation (B) and ozone application (C).

Methodology

Lysimeter Experiment

Figure 4: Experiment setup

Methodology

Lysimeter Experiment

Figure 5: Detail of the lysimeter upper part.

Results

Table 1: Chemical composition of mining tailings (X-ray fluorescence).

Substance	Content (%)	Substance	Content (%)
Al_2O_3	21,78	B_2O_3	-
CaO	0,47	Li_2O	-
Fe_2O_3	5,39	BaO	<0,1
K_2O	1,94	Co_2O_3	<0,1
MgO	0,65	Cr_2O_3	<0,1
MnO	<0,05	PbO	<0,1
Na_2O	0,38	SrO	0,09
P_2O_5	<0,05	ZnO	<0,1
SiO_2	52,65	ZrO_2+HfO_2	<0,1
TiO_2	0,9	Perda ao Fogo	15,56

Qualitative Chemical Analysis	
Majority Elements	**Al,Si**
Elements in small percentage	**Fe,K,Ti,Ca,Mg,Na**
Trace Elements	**Mn,P,S,Cr,Zn,Sr,Zr**

Results

- ph/Eh➔ Fast AMD formation
- Persistence throughout treatment/time.

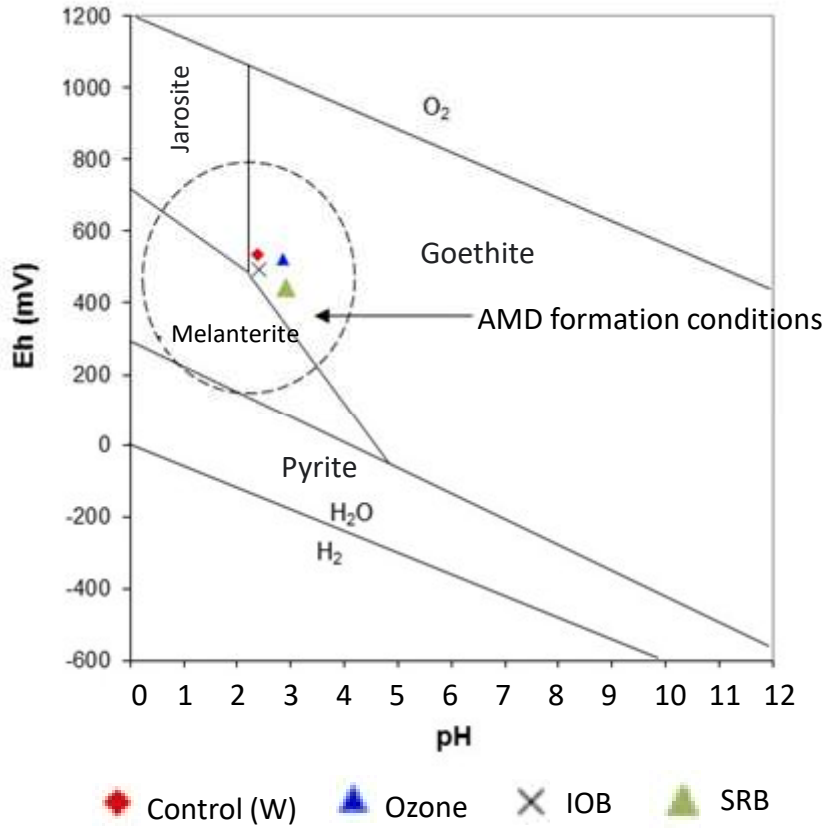

Figure 6: pH/Eh diagram

Results

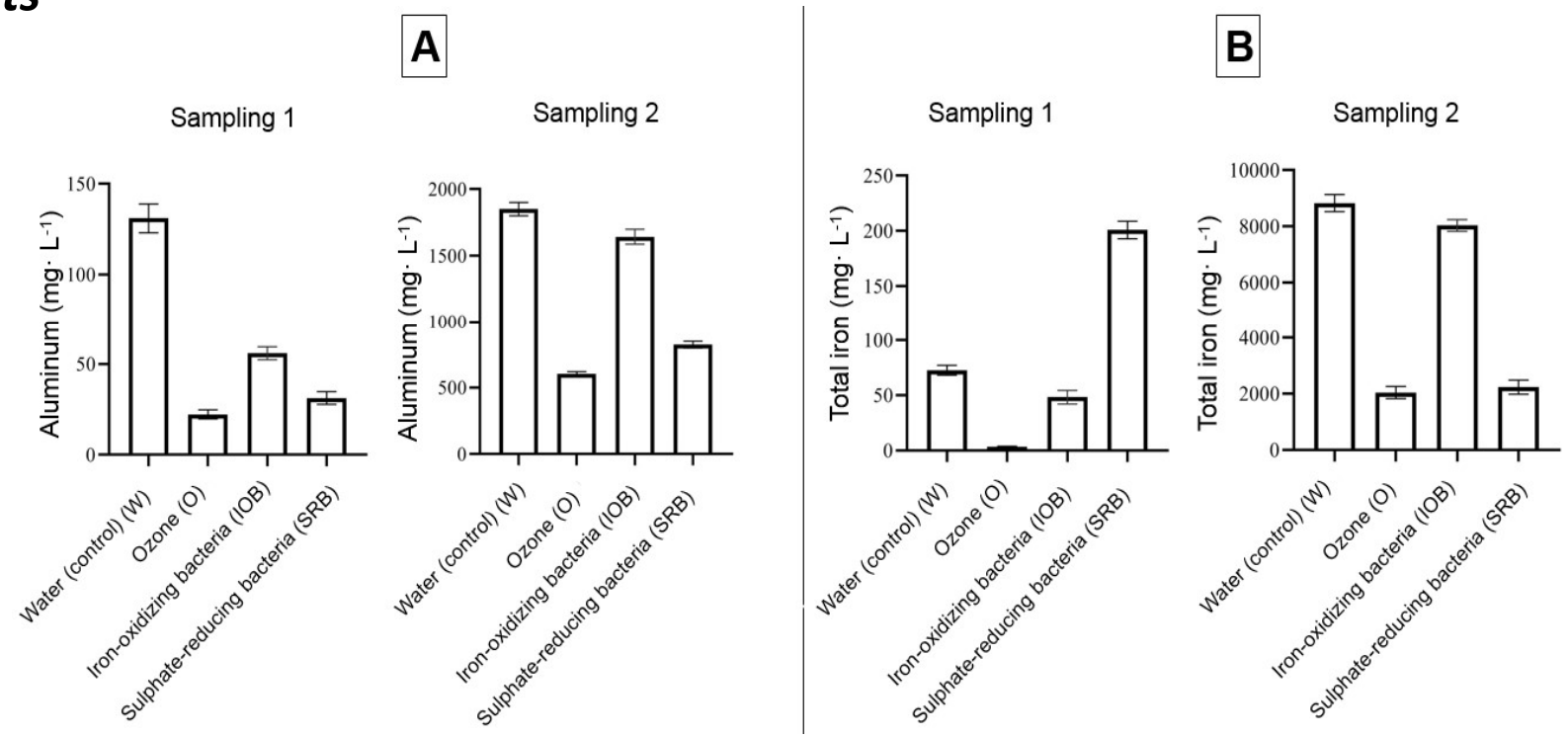

Figure 7: Aluminum (A) and total iron (B) concentration for samplings 1 and 2.

Results

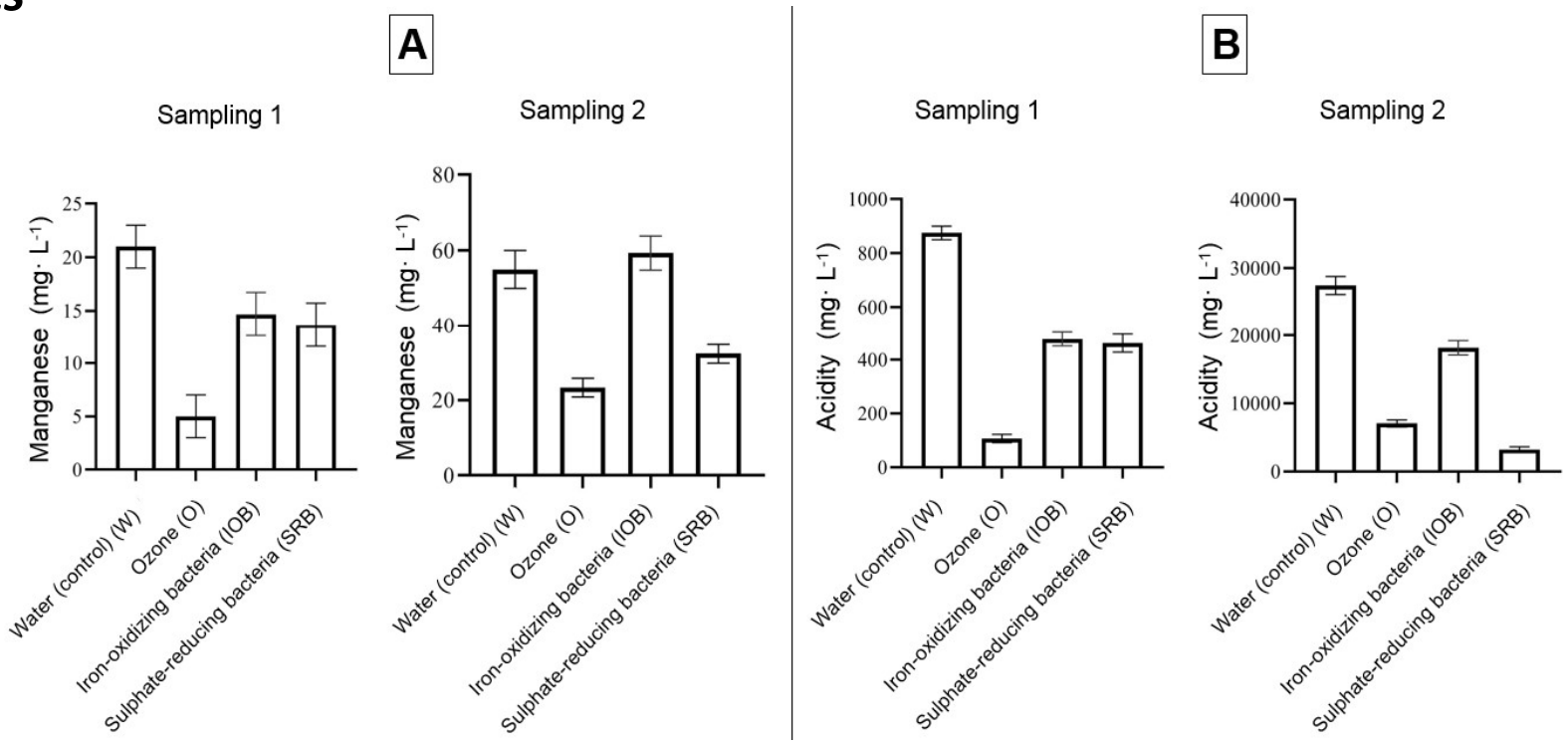

Figure 8: Manganese concentration (A) and acidity (B) for samplings 1 and 2.

Results

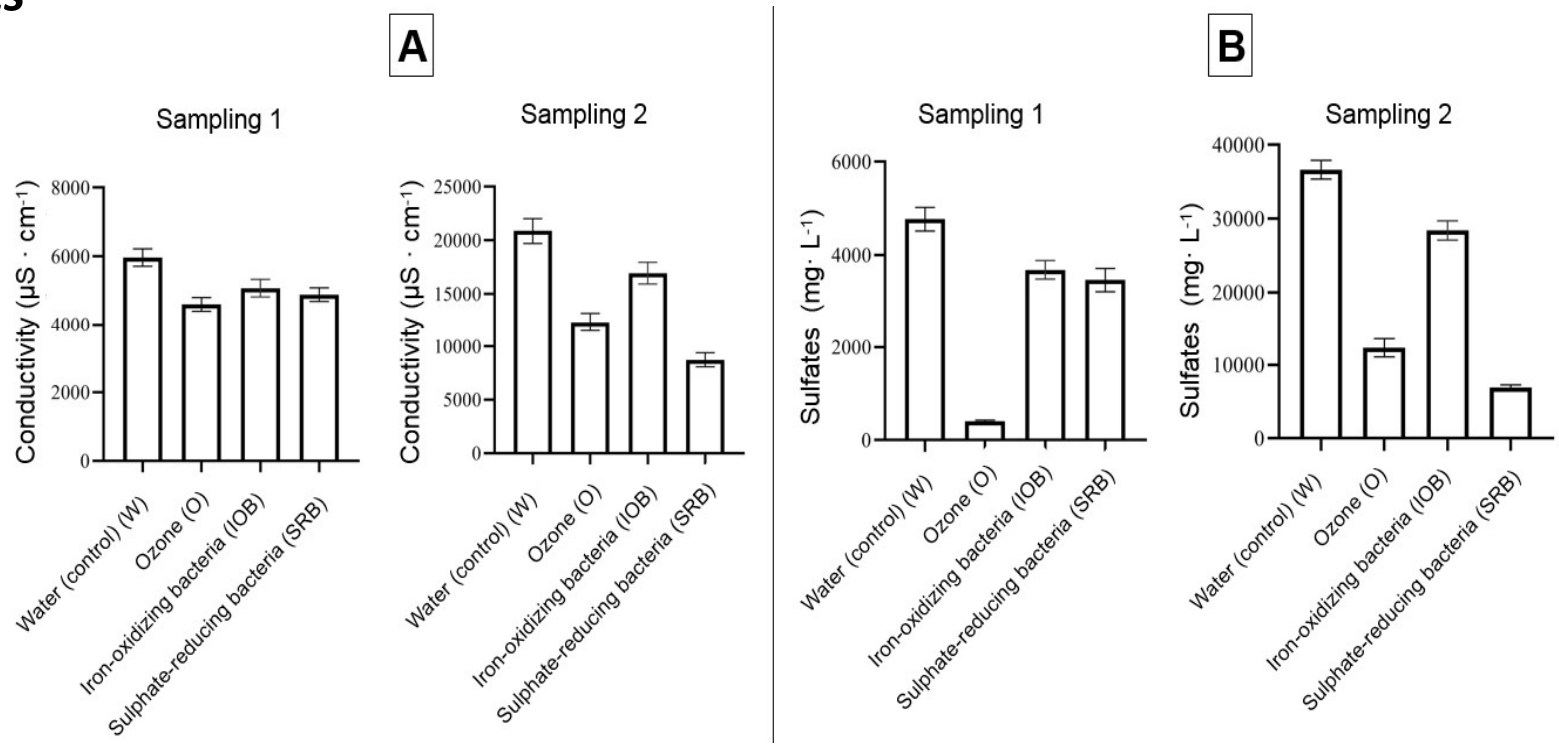

Figure 9: Electrical conductivity (A) and sulfates concentration (B) for samplings 1 and 2.

Results

There was no presence of SRB after 2 months of treatment

The amount of IOB is significantly reduced when ozone is applied.

The SRB group shows the highest amount of IOB.

→ Probably associated with the sugarcane molasses added to this group

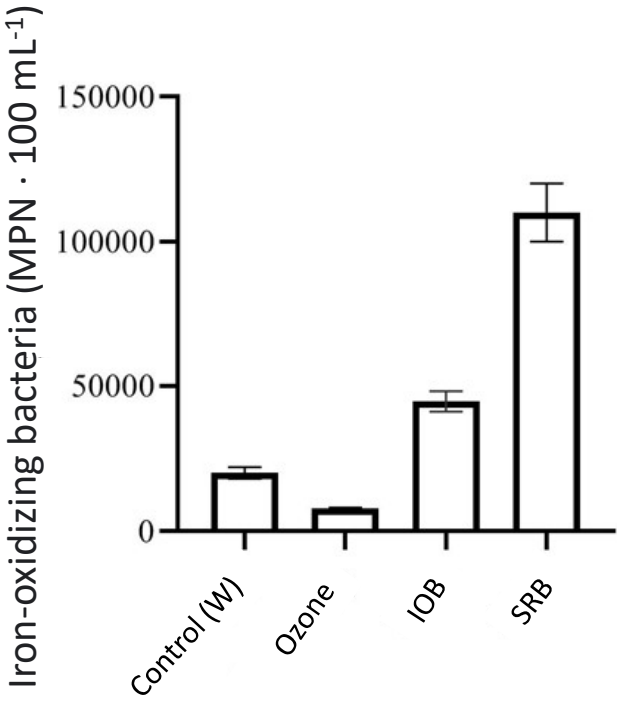

Figure 10: Most probable number (MPN) of IOB for experimental groups.

Conclusions

The *in situ* chemical oxidation of coal mining tailings using ozone enhances metal leaching, causes a drop in pH and increases the reduction potential (Eh) of the liquid that percolates the tailings.

→ + high electrical conductivity and acidity are indicative of a substantial increase in the generation of AMD.

Faster extinction of the sulfur content of coal mining tailings ➔ should lead to mitigation of the formation of AMD.

- Ozone acts to eliminate microorganisms.
- Ozone plays an important role in the formation of leachate.

This work represents a contribution to the challenge of stabilizing tailings piles.

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Thanks!