PASSIVE TOTAL METAL REMOVAL FROM ACID MINE DRAINAGE USING DISPERSED ALKALINE SUBSTRATES

Francisco Macías [1*], Manuel A. Caraballo [1], José Miguel Nieto [1], Tobias S. Rötting[2] and Carlos Ayora [3]

[1] Department of Geology, University of Huelva. Avda. Fuerzas Armadas s/n, 21071 Huelva, Spain. (*francisco.macias@dgeo.uhu.es)

[2] Technical University of Catalonia (UPC) , Hydrogeology Group, E-08034 Baracelona, Spain.

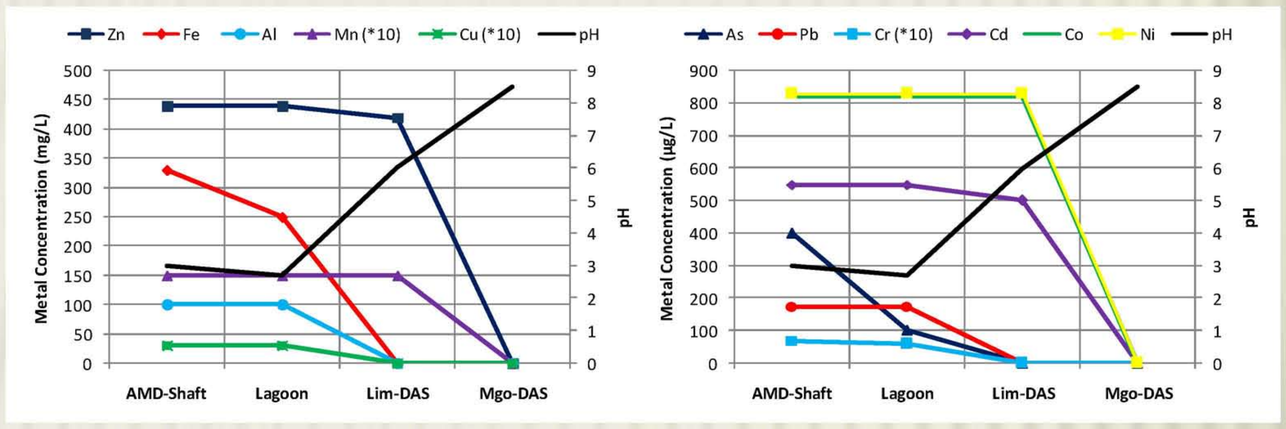
[3] Institute of Environmental Assessment and Water Research, CSIC, Jordi Girona 18, E-08034 Barcelona, Spain.

INTRODUCTION.

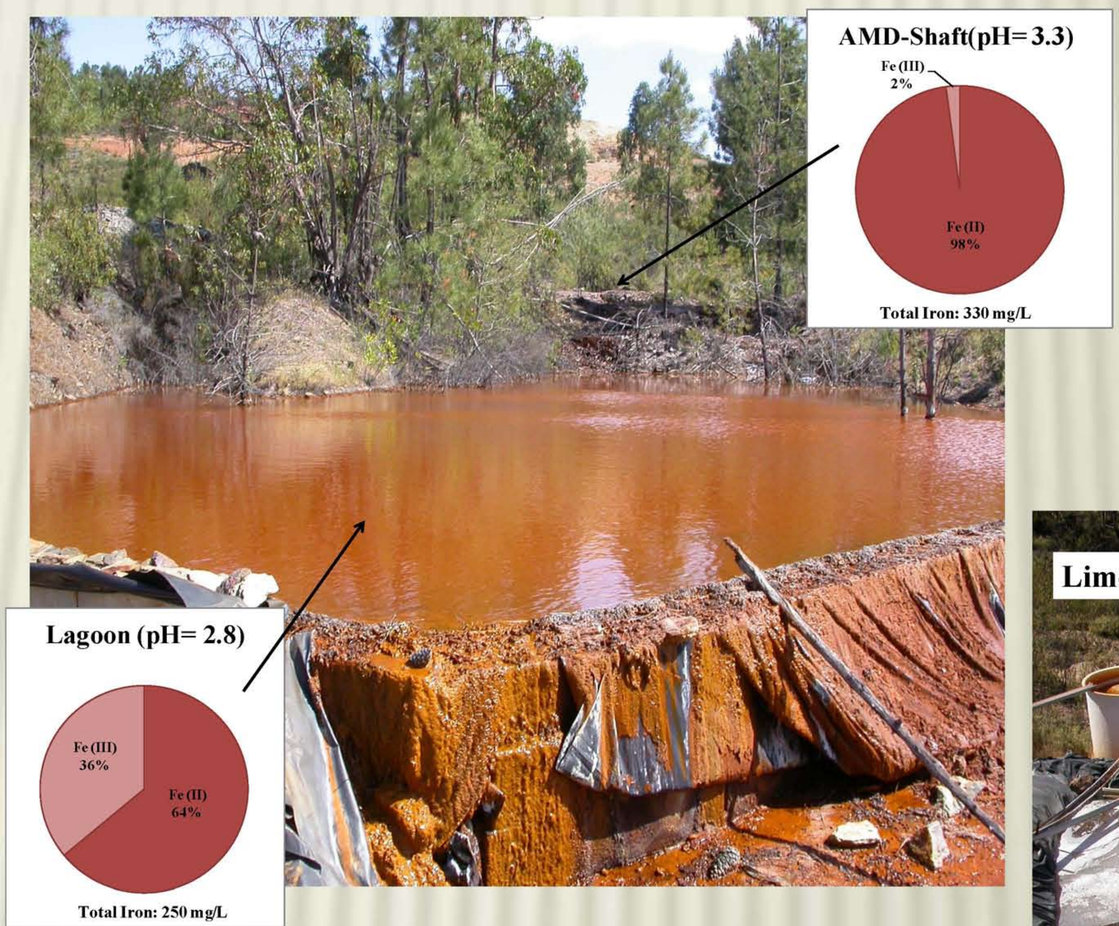
Acid Mine Drainage (AMD) is one of the principal environmental problems caused by sulphide mining activity. A clear example for this pollution is the Iberian Pyrite Belt (IPB), where two of the main rivers, Tinto and Odiel, present high levels of AMD pollution. Conventional passive treatment systems cannot be used to remediate AMD with high metal concentrations, because clogging and loss of reactivity occurs quickly. In order to overcome these problem, a dispersed alkaline substrate (DAS) made up of calcite sand dispersed in wood flakes was developed at laboratory [1], pilot [2,3], and full scale [4]. However, total metal removal was not achieved in such previous experiences due to the high pH required to precipitate solid phases of divalent metals such as Zn, Mn, Cd, Co and Ni. This summary shows the first results from a new pilot experience under operation, based on the AMD treatment by adding a DAS system with caustic magnesia (MgO), subsequent to the already tested DAS of calcite. The MgO-DAS performance had been already tested at laboratory column scale [5].

METHODS.

The system is subdivided in two different parts: a natural attenuation pretreatment in a lagoon and the DAS passive treatment system. A lagoon with 100 m^3 of capacity stores the AMD from the mine shaft and by microbial activity an important quantity of Fe is oxidized and precipitated. A pipe takes the AMD from the lagoon to the input of DAS treatment, which is infiltrated into two tanks of 3 m^3 in volume filled with calcite-DAS reactive mixture and one tank of 1 m^3 filled with MgO-DAS mixture, and connected in series with four decantation ponds with 6 m^3 of capacity. The AMD emerging from the mine shaft displayed a pH near 3, a net acidity of 1800 mg/L as CaCO3 equivalents and contains a mean concentrations of 440 mg/L Zn, 330 mg/L Fe (95% Fe(II)), 3600 mg/L sulphate, 250 mg/L Ca, 100 mg/L Al, 15 mg/L Mn and 0.1-3 mg/L Cu, As, Pb, Cr, Cd, Co and Ni. The flow of the AMD in the system is regulated at the input of the first tank to 1 L/min, to obtain a residence time of 1.5 days in each limestone tank, 3 days in each decantation pond and 0.5 days in the MgO tank. The hydrochemistry of the water was sampled at different points throughout the main parts of the system at least twice a month. The physicochemical parameters were measurement in situ, and the major chemical composition was analyzed by ICP-OES.

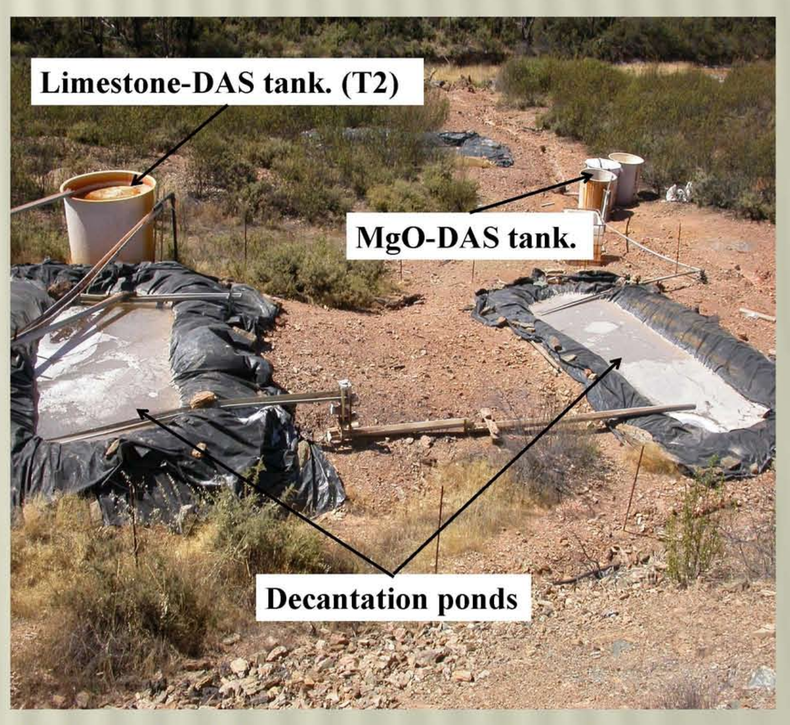


Major and trace metals and pH distribution at the outflow points of the system.

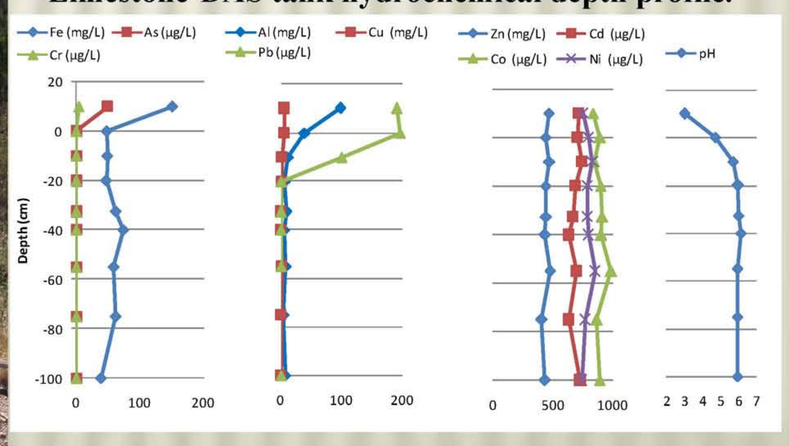


RESULTS AND DISCUSSION.

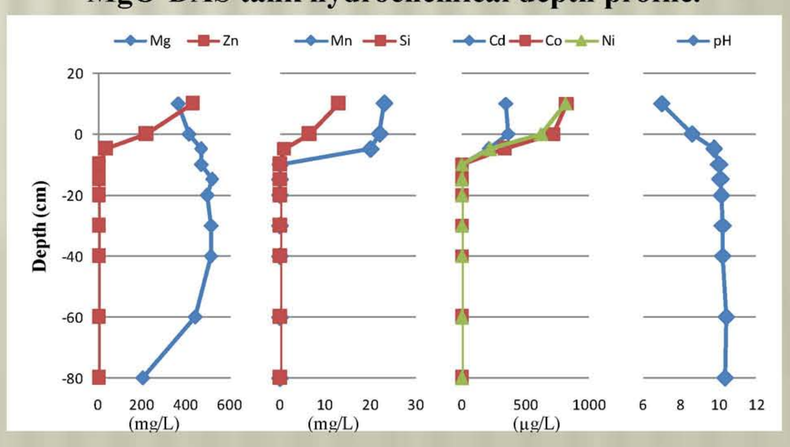
The monitoring performed during 4 months has shown a total metal removal from AMD. The natural attenuation in the lagoon promote an important Fe removal, from 330 to 250 mg/L, together with which at least 70% of total As is eliminated. In the limestone-DAS, pH value increased from 2.8 to 6 due to calcite dissolution, and Fe and Al oxyhydroxides (schwertmannite and basaluminite) precipitated removing completely both metals from the water. Moreover, As, Cu, Cr and Pb were also eliminated, sorbed and coprecipitated with the hydroxides. Finally, magnesium oxide hydration to $Mg(OH)_2$ and subsequent dissolution increased pH from 6 to 8.5 causing the precipitation of divalent metal (Zn, Mn, Cd, Co and Ni) solid phases (carbonates) and achieving their complete removal from the water.



Limestone-DAS tank hydrochemical depth profile.



MgO-DAS tank hydrochemical depth profile.



CONCLUSIONS.

A pilot scale passive remediation system, made up of a natural attenuation lagoon, two limestone-DAS tanks and a MgO-DAS tank has been able to eliminate all dissolved metals from an AMD source with high metal concentrations. An essential aspect was the installation of a lagoon prior to DAS, as it oxidized and precipitated a significant load of Fe and improved the DAS performance.

REFERENCES.

[1] Rötting *et al* (2008a) Journal of Environmental Quality, **37**,1741-1751

[2] Rötting *et al* (2008b) Applied Geochemistry, **23**, 1660-1674.

[3] Caraballo *et al* (2009) Applied Geochemistry **24,** 2301-2311.

[4] Caraballo *et al* (2008) Macla **9**, 61-62.

[5] Rötting *et al* (2008c) Environmental Science and Technology, **24** (42), 9370-9377