Persistence of Metal-rich Particles Downstream Zones of Acid Drainage Mixing in Andean Rivers

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1 INTRODUCTION

- Upper Andean watersheds are at the center of a **sustainability challenge**: mining developments can conflict with the supply of safe and sufficient water.
- In rivers impacted by acid drainage, confluences with non-impacted rivers can shift the fate of toxic metals, through formation of reactive particles with the capacity to sorb metals
- We studied the upper Mapocho basin, a naturally impacted watershed located in an area where a large Cu mining development is expected.

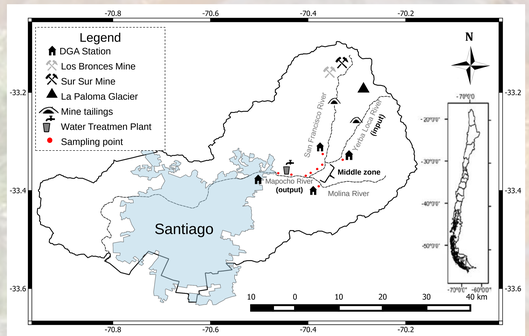


Figure 1:Mapocho Watershed, located in Santiago, Chile

2 METHODS

- Field campaigns were performed between 2015 to 2016, focused on the melting period. In-situ wet chemistry measurements and sampling were made on the main rivers and after the mixing sites.
- Water flow records of the DGA (the Chilean Water Agency) together with main ions concentration were used to calculate the mixing ratio and dilution factors downstream confluences.
- Total and dissolved metal concentration were analyzed by ICP-OES, while Particle Size Distribution (PSD) and Volume of Particles by laser diffraction.

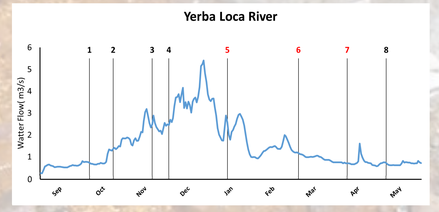
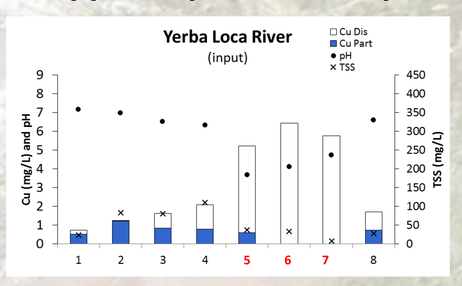


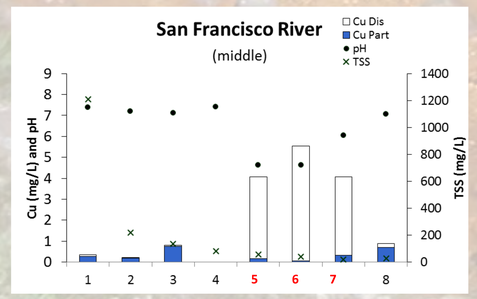
Figure 2. Yerba Loca water flow regime and sampling dates

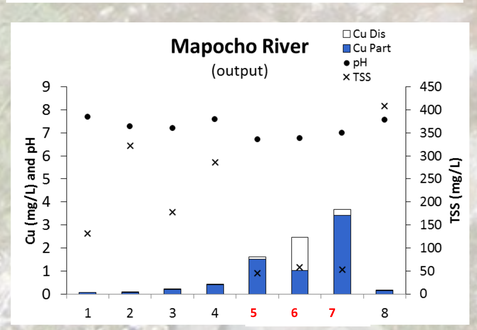
3 RESULTS

Copper: inputs and output



- 86 ± 14% of the inputs of copper in the watershed come from Yerba Loca River (3.0 ± 2.2 mg/L, pH between 3.7 and 7.2).
- The concentrations of Cu increased at the middle-end of the melting period (January to April) and enter the watershed mainly in dissolved form at this period of the year (on average, 90% of the total concentration).

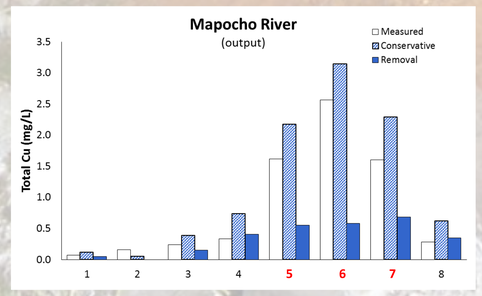




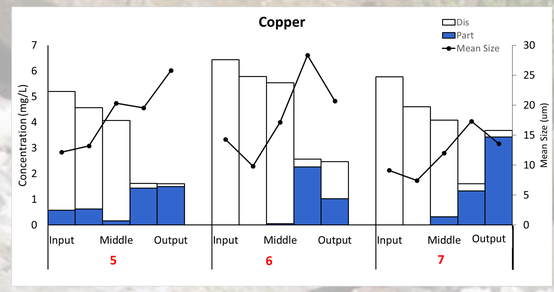
- After mixes, Cu is reduced to 0.86 ± 0.94 mg/L. with less than 20% on dissolved form.

Dilution or removal?

- At the output site, the measured concentration of Cu was compared with the calculated concentration assuming conservative mixes and dilution
- The results showed a removal on the total Cu between 0 and 1.13 mg/L (0 - 55%)



4 BEHAVIOUR OF THE FORMED PARTICLES



- During periods of high Cu concentration, there was an increase on the volume and mean size of particles downstream confluences. This increment was related with the shifts of Al toward the particulate form (R^2> 0.79).
- These Al particles, formed due to the increase of pH after confluences, settled few meters after mixes and persisted until Mapocho river (output).
- Due the high SO_4^{2-} concentration (> 250 mg/L), these precipitates would be Al hydroxysulphates. These particles would drive the fate of Cu through sorption and settling processes [1].

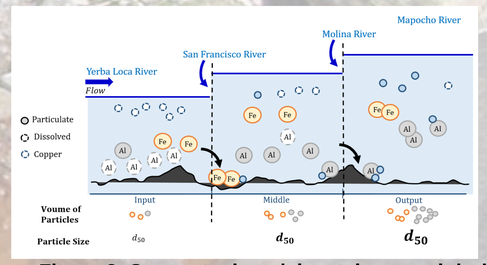


Figure 3. Conceptual model metal removal during Periods of high concentration of Cu

5 CONCLUSIONS

- In the high Mapocho Watershed, melting decreases pH and increase Cu concentration in Yerba Loca River above 5 mg/L.
- During periods of high concentration of Cu, confluences promotes the formation of Al reactive particles with the capacity of sorb Cu.
- The size and volume of these metal rich particles increase along the watershed, promoting the settling and removal of Cu.

REFERENCES

[1] Carrero, S.et al.,(2015). The potential role of aluminium hydroxysulphates in the removal of contaminants in acid mine drainage. Chemical Geology, 417, 414-423.

ACKNOWLEDGEMENTS

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