Determination of the dissolved contaminant load transported by Meca river (Huelva, Spain)

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Introduction

The drainage network of the Odiel river (SW Spain) is intensively contaminated by acid mine drainage (AMD). The Odiel river basin drains the materials of the Iberian Pyrite Belt (IPB), a large metalogenic province hosting numerous, large scale massive sulphide deposits. Sulphide oxidation takes place once the minerals are exposed to atmospheric conditions, generating acidity and releasing sulphates, Fe and accessory metals (As, Co, Cu, Pb, Zn, etc.). In figure 1 can be observed the affected streams (in red).

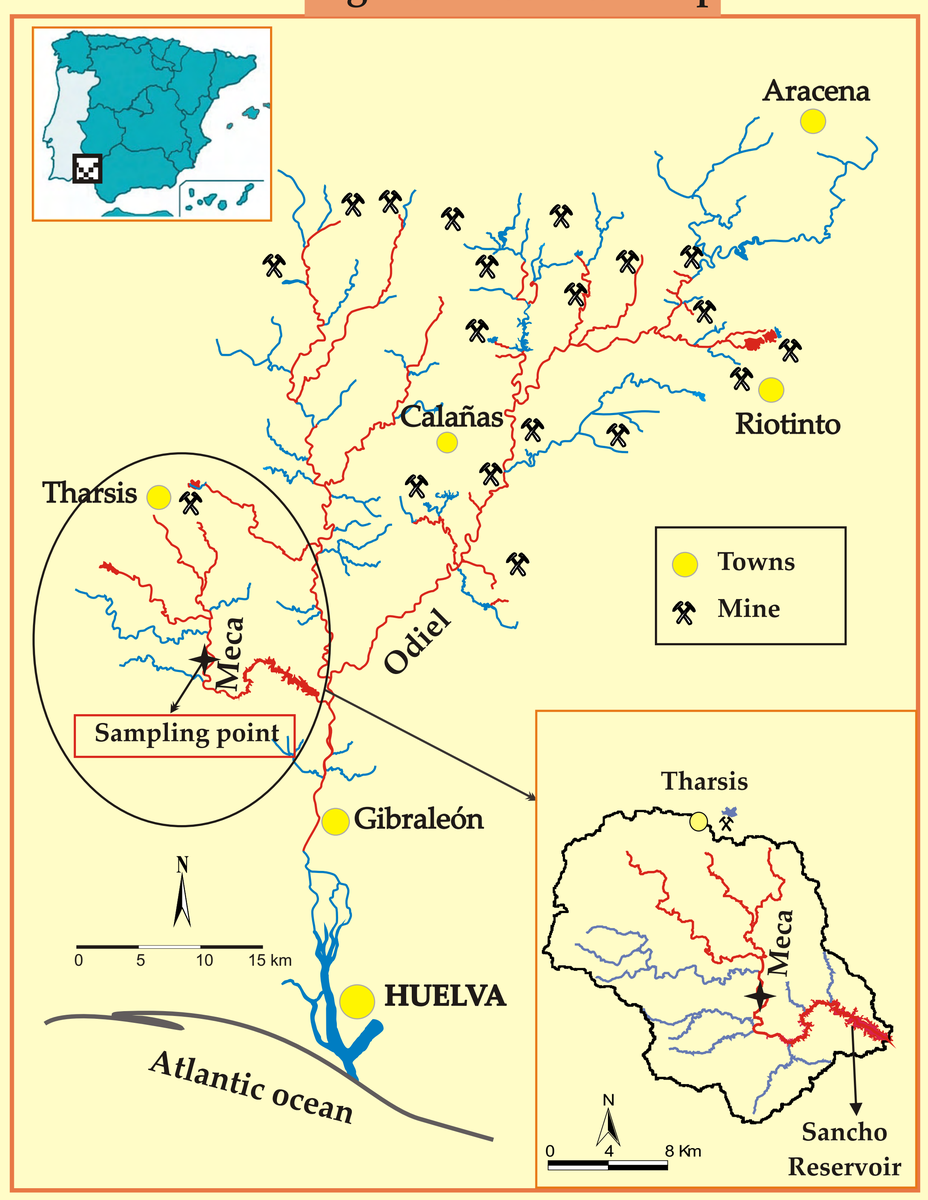
The aim of this study is to cuantify the contaminant load transported by the fluvial network of the Meca river, tributary of the Odiel by its west margin. This stream, with a watershed of 315 km^2 of surface, is strongly affected by acid lixiviates from Tharsis mine (Fig.1) and is regulated by the Sancho dam. Water of this reservoir (with a capacity of 58 hm^3) is acid with a pH value close to 4.2 and elevated concentrations of toxic elements (Sarmiento, 2007).

Methodology

Several samplings to control the Meca river water quality were carried out during the hydrologic years 2003/04 to 2005/06. The sampling point is located before the reservoir and collects the streams affected by AMD (Fig.1). *In situ* were determined pH, electrical conductivity, redox potential, dissolved oxygen and temperature. Samples were filtered and numerous elements were analyzed in the lab by ICP-OES (Sarmiento, 2007).

SWAT (Neitsch *et al*., 2002) was used to obtain the water discharges in the sampling point. This progam allows to predict the behavior of complex hydrologic watersheds. SWAT needs topographical information, soils characteristics, types of soil uses and climatic data (rainfall and temperature). The model has been calibrated and validated with daily discharge data from the Sancho reservoir (Galván *et al.*, 2007).

Figure 1: Location Map



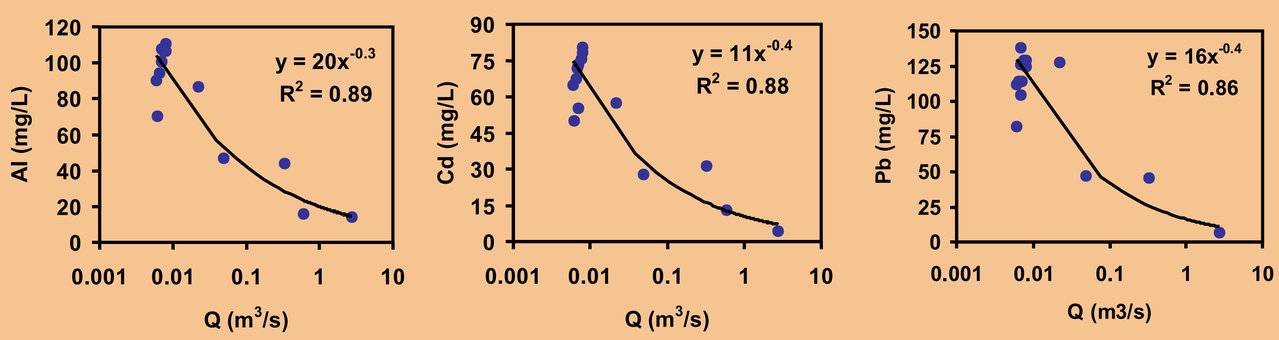


Figure 2. Some relationships between discharge and concentration

	Cc (ton/year)
Al	418
Ca	561
Cd	0.20
Co	6
K	38
Li	0.62
Mg	918
Mn	81
Na	798
Ni	2
Pb	0.3
Se	73
Si	101
Sr	2
Zn	121
SO_4	8024

Table 1. Annual mean load transported by the Meca river

	Measured values	Simulated values
Al (mg/L)	2.96	5.26
Ca (mg/L)	12.3	10.9
Cd (µg/L)	< d.l	2.42
Co (µg/L)	72.0	77.6
K (mg/L)	2.71	1.22
Li (µg/L)	12.1	13.1
Mg (mg/L)	13.5	14.2
Mn (mg/L)	1.71	0.99
Na (mg/L)	16.1	13.4
Ni (µg/L)	30.7	29.0
Pb (µg/L)	16.7	8.56
Se (mg/L)	not determinated	0.87
Si (mg/L)	3.43	1.92
Sr (µg/L)	65.1	38.8
Zn (mg/L)	1.85	1.55
SO_4 (mg/L)	121.2	106.6

Table 2. Calculated and analyzed Values in the reservoir

Results and Conclusions

The relationship between discharge and dissolved element concentration in a river is often expressed using the equation (Igarashi *et al.,* 2003):

$$C = \alpha Q^{\beta}$$

Where C is the element concentration, Q is water discharge and α and β are constants depending on the element. In figure 2 some examples of the encountered relationships are showed.

From the daily water discharge obtained by SWAT and these relationships we can obtain the daily concentration of an element and thus the daily contaminant load. The annual mean contaminant load (Cc) trasnported by the Meca river in the sampling point is shown in table I, for elements without a good correlation with discharge was not calculated. The contaminant load transported by the Mecar river to the Sancho reservoir was enormous, for example 8000 tons of sulphates, 420 tons of Al, etc. This agrees with data obtained from Olias et al. (2006).

To validate the methodology the dissolved element concentration in the Sancho reservoir was calculated. The sampling point drains the 62% of the watershed surface, the remaining surface draining to the Sancho reservoir (38%) has streams with good quality water. To obtain the final water quality in the reservoir concentrations values obtained in the sampling point were weighed with water quality data from others reservoirs of the basin unaffected by AMD, in base to the watershed surface (62% - 38%). In general, the calculated water quality of the Sancho reservoir shows a good agreement with the analyzed concentrations (table 2), which supports the validity of these results.

References

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