BIOAVAILABILITY, ECOTOXICITY AND GEOLOGICAL CHARACTERISTICS OF TRACE LEAD IN SEDIMENTS FROM TWO SITES ON RÍO NEGRO RIVER, URUGUAY

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Introduction

Lead is a toxic heavy metal that can be deposited in bed sediments, usually associated to particulate matter of iron and manganese oxides. Thus, sediments become a route of exposure to Pb for aquatic organisms. Benthic organisms ingest and come in contact to particulate, dissolved and sediment-bound Pb. Lead associated with sediment fractions that exhibit cation-exchange capacity or that are easily reduced is generally more bioavailable than that associated with other fractions. Furthermore, changes in ambient environmental conditions can increase the bioavailability of Pb associated with inorganic solid phases and organic matter (CCME 1999).

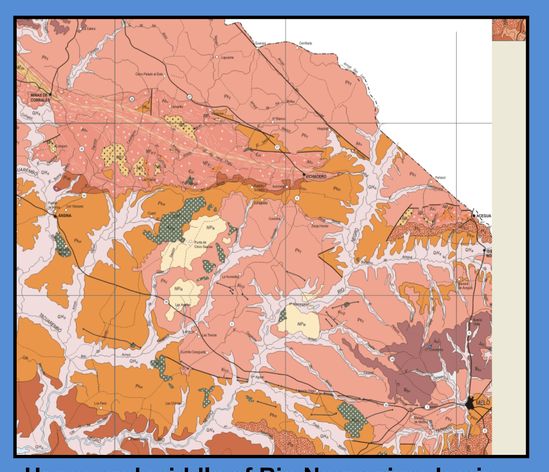
The bottom sediments in the North Western area of the Río Negro river, Uruguay, are composed of sedimentary rock deposits from the Gondwana continent. The reducing environment and particle size might be responsible of the characteristic water color. The clay fraction is a laminated structure of phylosilicate with SiO_4 and alumina groups. The minerals are *montmorillonite* and *illite* of 2:1 structure, alternated with Aluminum *gibbsite*. The sequence of sedimentation which took place under oxidative conditions during the Carboniferous Period and started with extended deposits of *tillits*, associated to varvic lutite, sand and sea level deposits, indicative of circumpolar conditions. Permian Period sediments, which were placed under reductive conditions, are rich in fossil vegetation and bituminous lutite, which composes their carbonous fraction.

Aim

The aim of the research was to determine if lead could be a causative agent for the ecotoxicity effects evidenced through bioassays and to assess if its bioavailability could be linked to the grain size and clay fraction of the sediment and to the geological formation,

Materials and methods

Monthly samples at two sites on the Río Negro river at Baygorria and Rincón del Bonete locations were analyzed for both particle size and lead. Lead was determined by Atomic Spectrometry in river water according to ISO15586 and in sediment according to ASTM 3976-02/EPA 3051A/ISO11885 modified. Particle size of sediments was determined by sieving and sedimentation. Acute toxicity tests in the water column were carried out with the fish *Pimephales promelas* according to USEPA 821-R-02-012. For the whole sediment toxicity test, the growth and survival method with the amphipod *Hyallela curvispina was* based on USEPA 600/R-99/064 Test Method 100.1, 2000, modified. A screening method with the bacteria *Photobacterium leiognathi* was also applied to assess the metal and organic toxicity in a 1:4 elutriate.



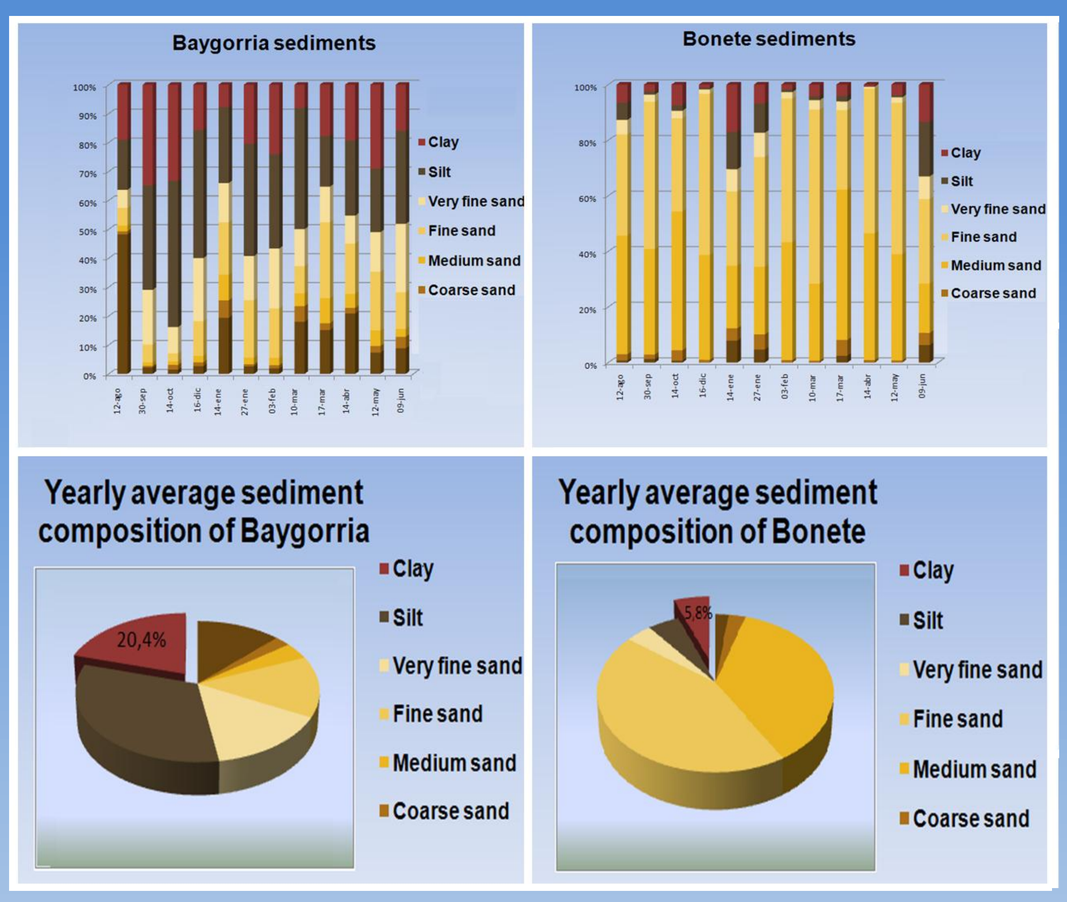
Upper and middle of Rio Negro river basin-geological map
F.Bossi (2001). Facultad de Agronomía. Universidad de la República

Results and Discussion

Lead analysis

Lead concentration in sediment. Concentrations above the quantification limit have grey background.

Lead (mg/kg) (dry basis)		
Sampling date	Baygorria	Bonete
12-08-08	<10	<10
01-10-08	<5	<1,5
14-10-08	<1,5	<1,5
03-02-09	12	<3,7
14-01-09	9,6	<3,0
27-01-09	6,9	<3,0
10-02-09	8,3	<5,0
10-03-09	7,6	<5,0
17-03-09	7,8	<5,0
14-04-09	8	<5,0
12-05-09	8,6	<2,0
09-06-09	7,2	<4,0



Sampling sites

Photographs by Dr. G. Veroslavsky - Facultad de Ciencias, UDELAR

Mangrullo / Frayle Muerto limestone and lutite formations at Cañada del Barón - Cerro Largo Province

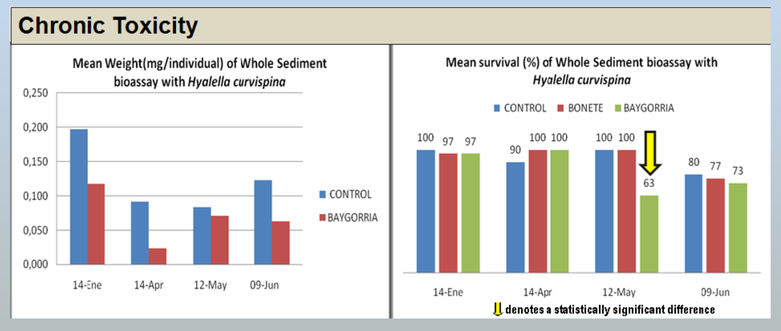
Bituminous lutite (Mangrullo – Permian formation)

Ecotoxicity tests

Acute toxicity				
	Elutriate		Sediment	Water column
	Photobacterium leiognathi		*Hyallela curvispina*	*Pimephales promelas*
	IC50 (n = 1)		Mean survival (n=4)	LC50 (n = 16)
	Metals	Organics		
Baygorria	1,8%	2,3%	83%	> 100 %
Bonete	6,3%	69,3%	94%	> 100 %

(*) CheckLight ToxScreen[3] Test Kit

Chronic Toxicity



Data showed that Baygorria´s sediments in average have a much higher percentage of clay than Bonete´s (20,4 % and 5,8 %, respectively). The lead determination was quantifiable in Baygorria´s sediments, meanwhile lead concentrations in Bonete´s sediments were always below the quantification limit. Lead concentrations of water samples were also always below the quantification limit (0,01µg/l), which is lower than the national regulation limit (0,03µg/l) for stream water.

Preliminary results of *Hyalella curvispina* growth and survival test in the sediment samples suggests a possible relationship between lead concentration, clay percentage and mean body weight obtained after the exposure of juvenile specimens to the sediments from Baygorria site. Although lead concentrations found in sediments from Baygorria are below the TEL (34 mg/kg Pb) determined for the reference amphipod *Hyalella azteca* (Bonnet, 2000), we found some evidence that the growth of the native amphipod *Hyalella curvispina* could be affected on this site.

Hyalella curvispina *Pimephales promelas*

Conclusions

These preliminary results suggest that higher toxicity was found in Baygorria when compared to Rincón del Bonete sediment samples. It could be postulated that the bioavailability of lead to organisms that interact with the sediment increases with higher clay fractions. However, an influence of other contaminants, for example organics, cannot be discarded. No toxicity was observed in the water column. These findings should be confirmed by further research.

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