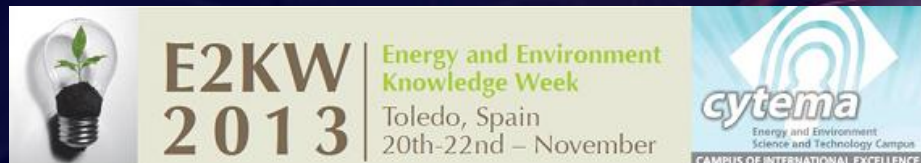


LEAD IN SHEEP EXPOSED TO MINING POLLUTION: IMPLICATIONS FOR ANIMAL AND PUBLIC HEALTH

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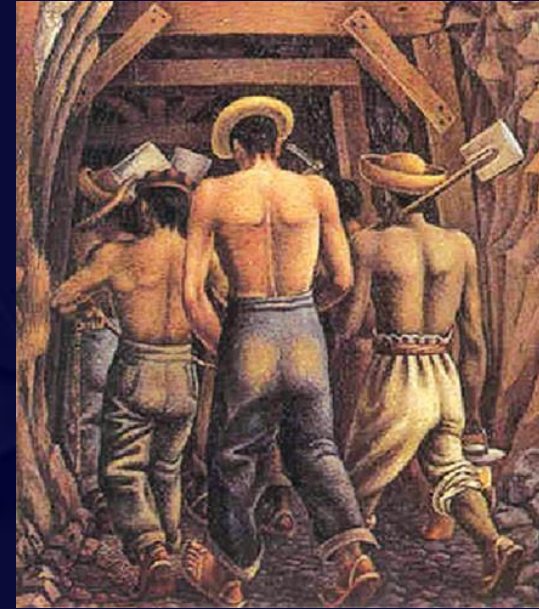
Introduction



Minerals are natural resources used by man

Mining activities have an environmental impact at all stages:

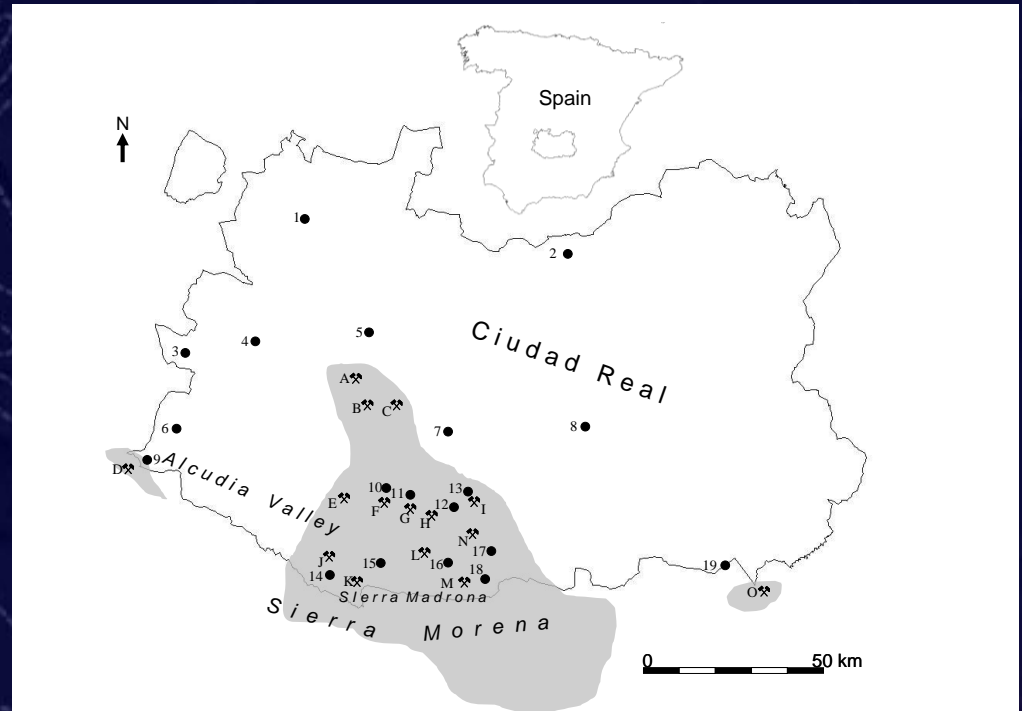
- extraction
- processing
- refining
- smelting
- waste accumulation



Restoration of polluted sites is expensive and in many cases land is just abandoned



Introduction



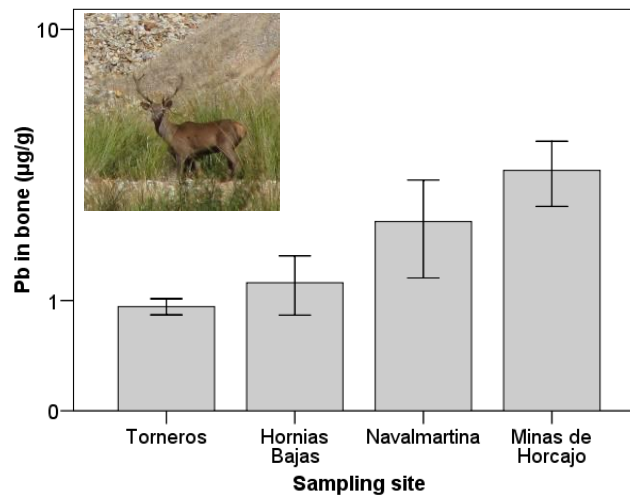
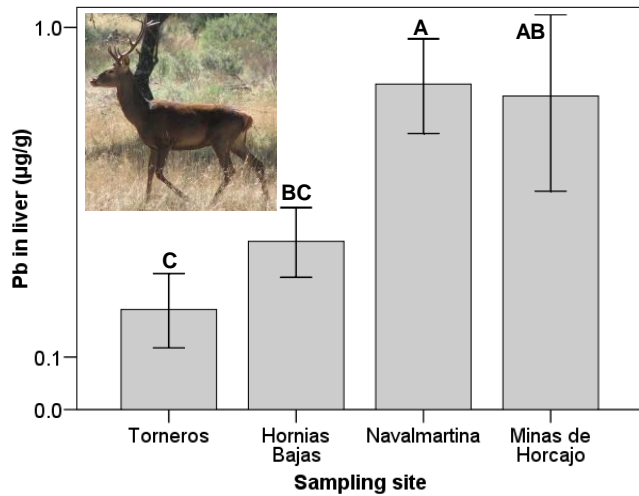
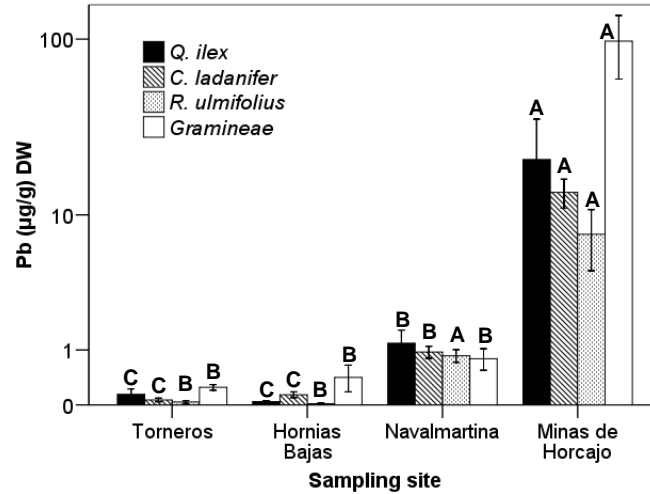
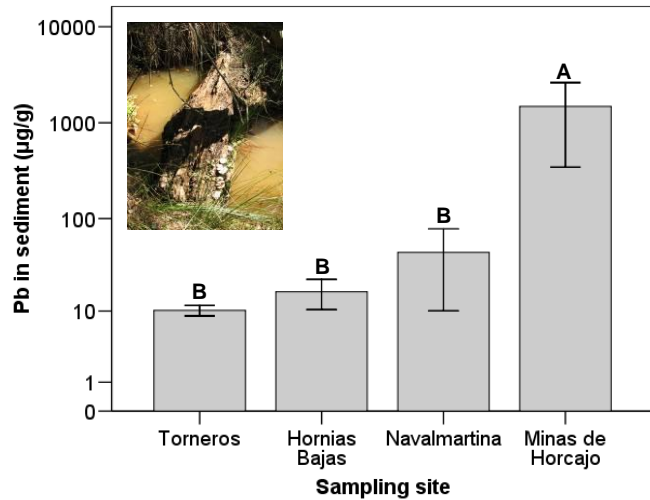
Pb mining in Alcudia Valley began in Roman times.

World's leading producer of Pb since the mid 19th century to the early 20th century.

484 mines in an area of 2500 Km²

Hevia (2003). Patrimonio Minero del Valle de Alcudia y Sierra Madrona
Higuera et al., 2012. *Journal of Geochemical Explorations*

Introduction



Reglero et al. (2008). *Science of the Total Environment*

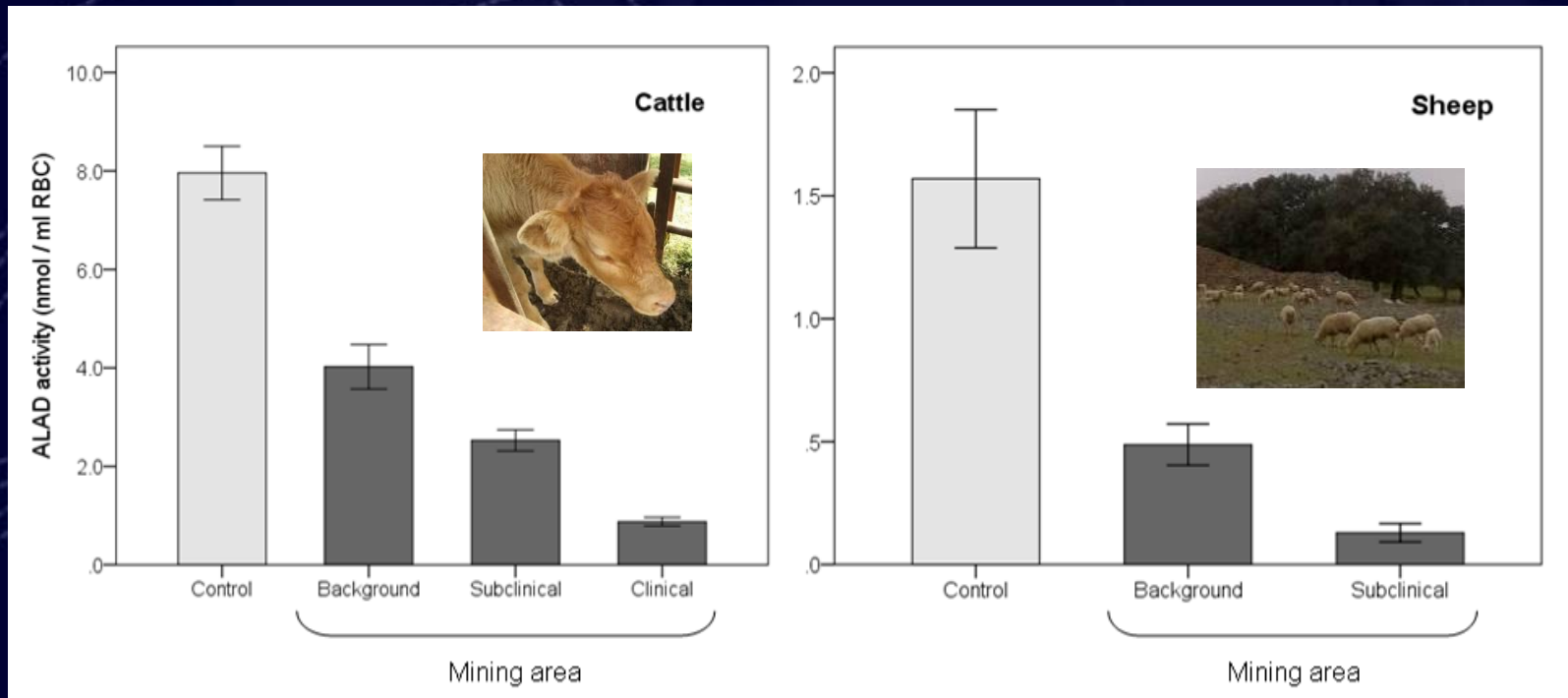
Introduction

- **Oxidative stress biomarkers:** GSH depletion. Reglero *et al.* (2009a) *Environmental Pollution*
- **Sperm quality:** Reduced acrosome integrity. Reglero *et al.* (2009b) *Environmental Pollution*
- **Fatty acid composition:** ↓20:4n-6 in testis and sperm. Castellanos *et al.* (2010) *Reproductive Toxicology*
- **Retinol and tocopherol levels:** ↓Retinyl esters. Rodriguez-Estival *et al.* (2011a) *Achives of Environmental Toxicology and Chemistry*, (2011b) *Science of the Total Environment*
- **Bone mineralization:** ↓carbonate content, increased free retinol. Rodriguez-Estival *et al.* (2013) *Environmental Pollution*
- **Immune function:** Changes in expression of cytokines. Rodriguez-Estival *et al.* (2013) *Environmental Toxicology and Chemistry*
- **Food safety:** 84% wild boar - 57% red deer >EU MRL for Pb in meat. Taggart *et al.* (2011) *Environment International*.



Introduction

- Accumulation in domestic animals (plants and ingestion of polluted soil)
- Especially marked in younger animals
- Pb levels ranging from 5.66 to 80.51 $\mu\text{g}/\text{dl}$ in blood.



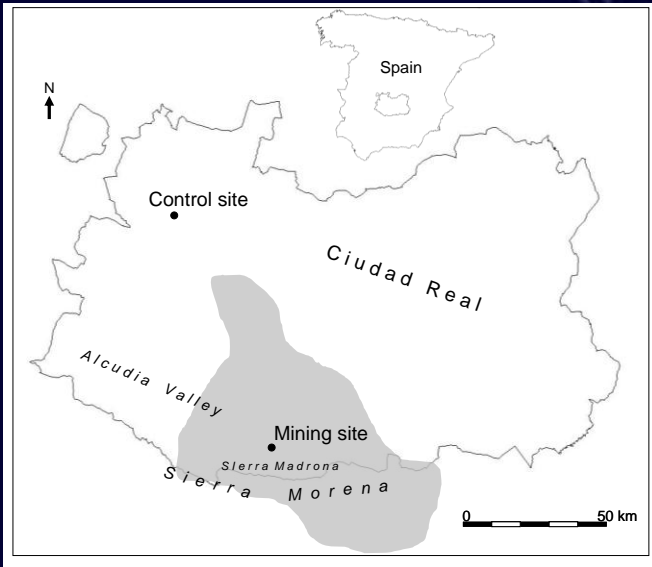
Differences in d-ALAD activity (mean SE) among controls and at each level of Pb exposure in cattle and sheep from the mining area (according to PbB threshold levels in livestock reviewed by Ma, 2011).

Objectives

- The overall goal was to study the exposure of sheep to Pb pollution from an abandoned mining district in order to:
 1. Evaluate the implications of Pb exposure in animal health.
 2. Assess the risks for human consumers of meat and offal of sheep from the polluted area.



Methods



Sample	n	Pb concentration		Classification
		Mean	Range	
Soils $\mu\text{g/g}$	8	8,897	414-65,858	Soils highly polluted ($>300 \mu\text{g/g}$; Directive 86/278/EEC)
Plants (mostly Gramineae) $\mu\text{g/g}$	10	52.6	2.3-182.7	Plants potentially toxic to livestock ($>30 \mu\text{g/g dw}$; Chaney 1989)
Water $\mu\text{g/L}$	4	26.6	12.9-43.8	Exceeds the maximum level destined for human consumption ($>25 \mu\text{g/L}$; Directive 98/83/EEC)

Methods



Pb levels in soils and plants are expressed in $\mu\text{g/g}$ dry weight and for water in $\mu\text{g/L}$

Methods

Sample	Control (n) Adult females	Mines (n)		
		Subadult males	Adult males	Adult females
Blood	20	16	1	27
Liver	21	-	-	32
Muscle	21	-	-	32

Blood: Dilution with Triton
0.1%

Tissues: Lyophilized +
Digestion in thermoblocks



Farm

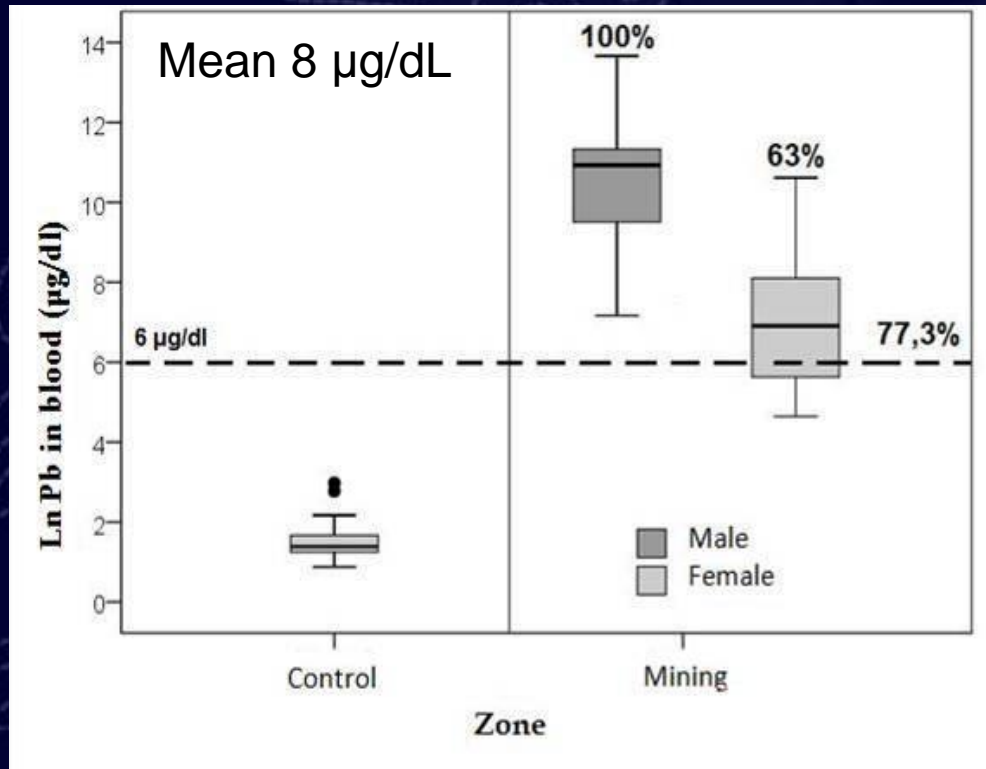


Slaughterhouse



GF-AAS: 95-98±5%

Results and Discussion



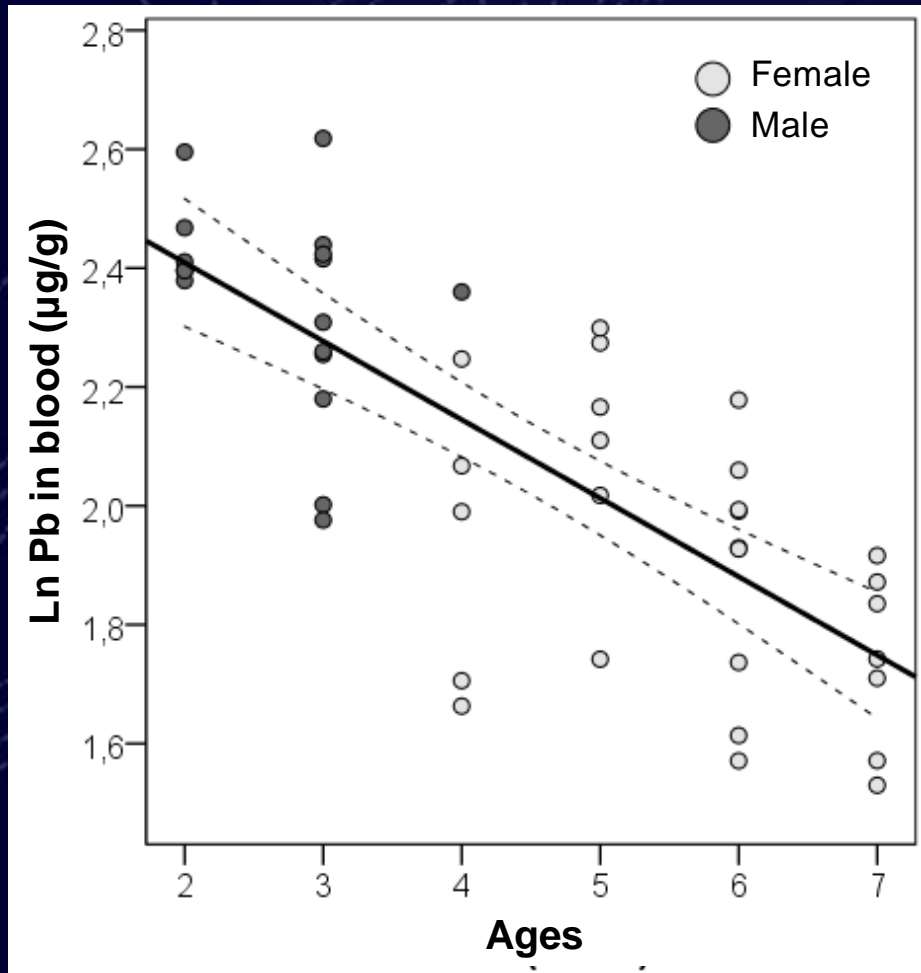
Subclinical poisoning 6-35 µg/dl
Ma (2011) Environmental Contaminants
in Biota



Pb levels in blood according to zone and sex.

Smith. et al. (2010) *Science of the Total Environment*. 0.3 – 27.5 µg/dl in UK

Results and Discussion

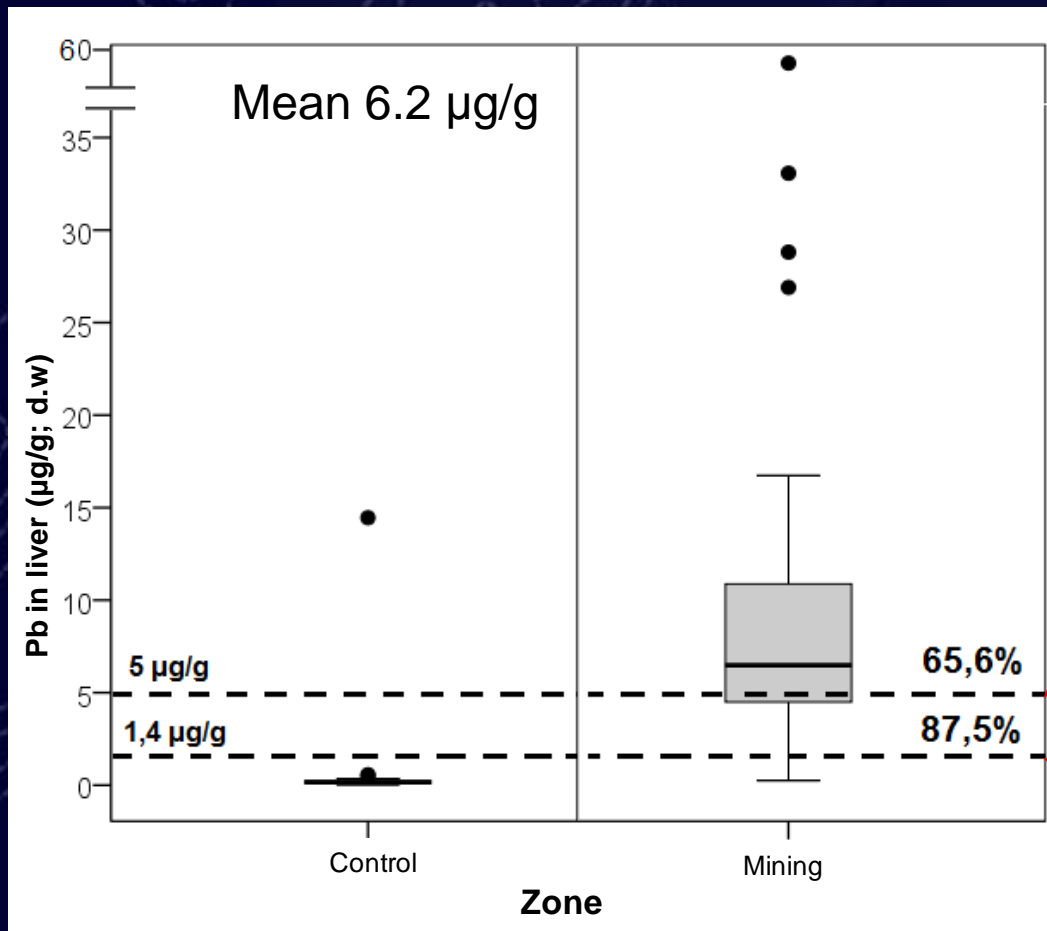


Relationship between blood Pb levels and age in sheep from the mining area ($r = -0.758$, $P < 0.001$).



Higher rates of gastrointestinal absorption of Pb in the younger animals

Results and Discussion



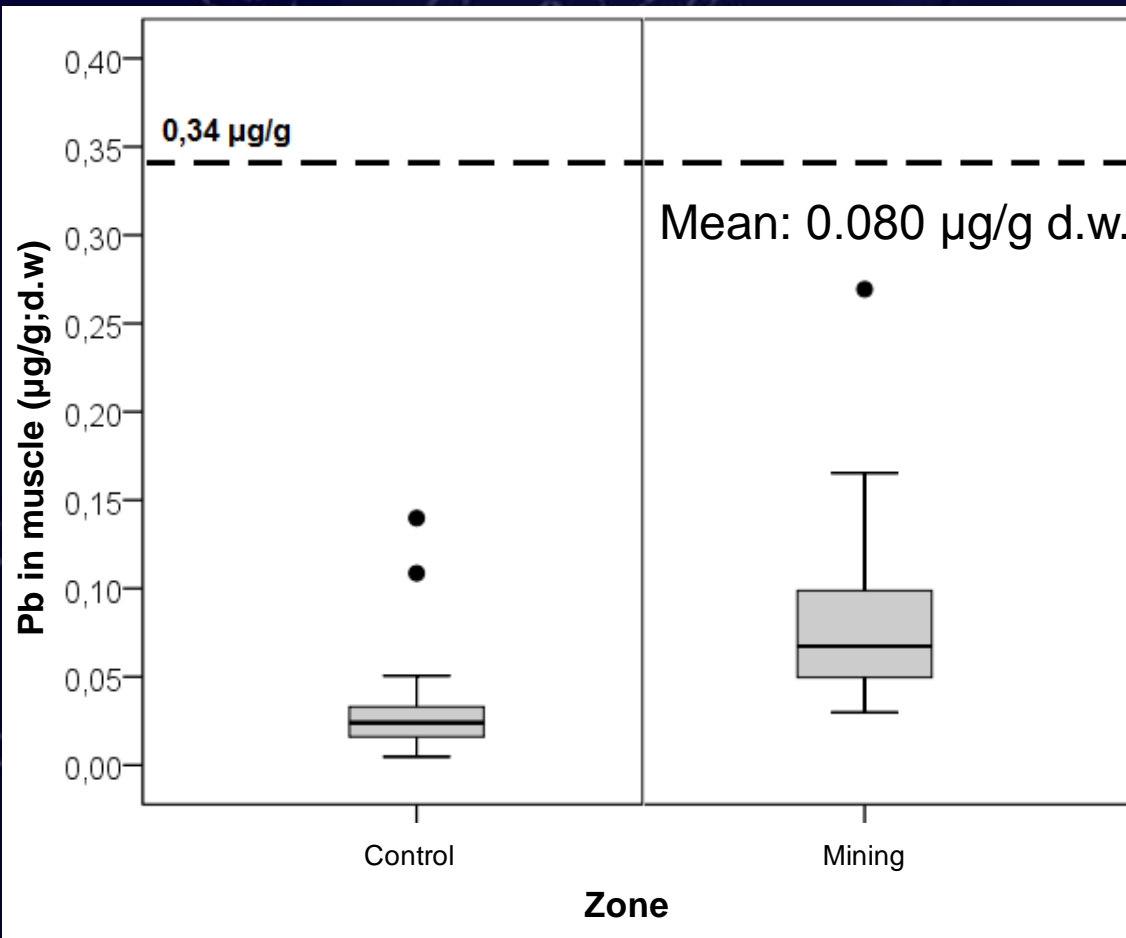
Toxic effect level
>5 µg/g d.w
Ma (2011) Environmental
Contaminants in Biota

EU MRL for offal
1.4 µg/g d.w =
0.5 µg/g w.w

Animal health and public health

Phillips et al. (2011) *Small Ruminant Research*: 18.3 µg/g d.w.

Results and Discussion



EU MRL for meat:
0.34 $\mu\text{g/g d.w.}$

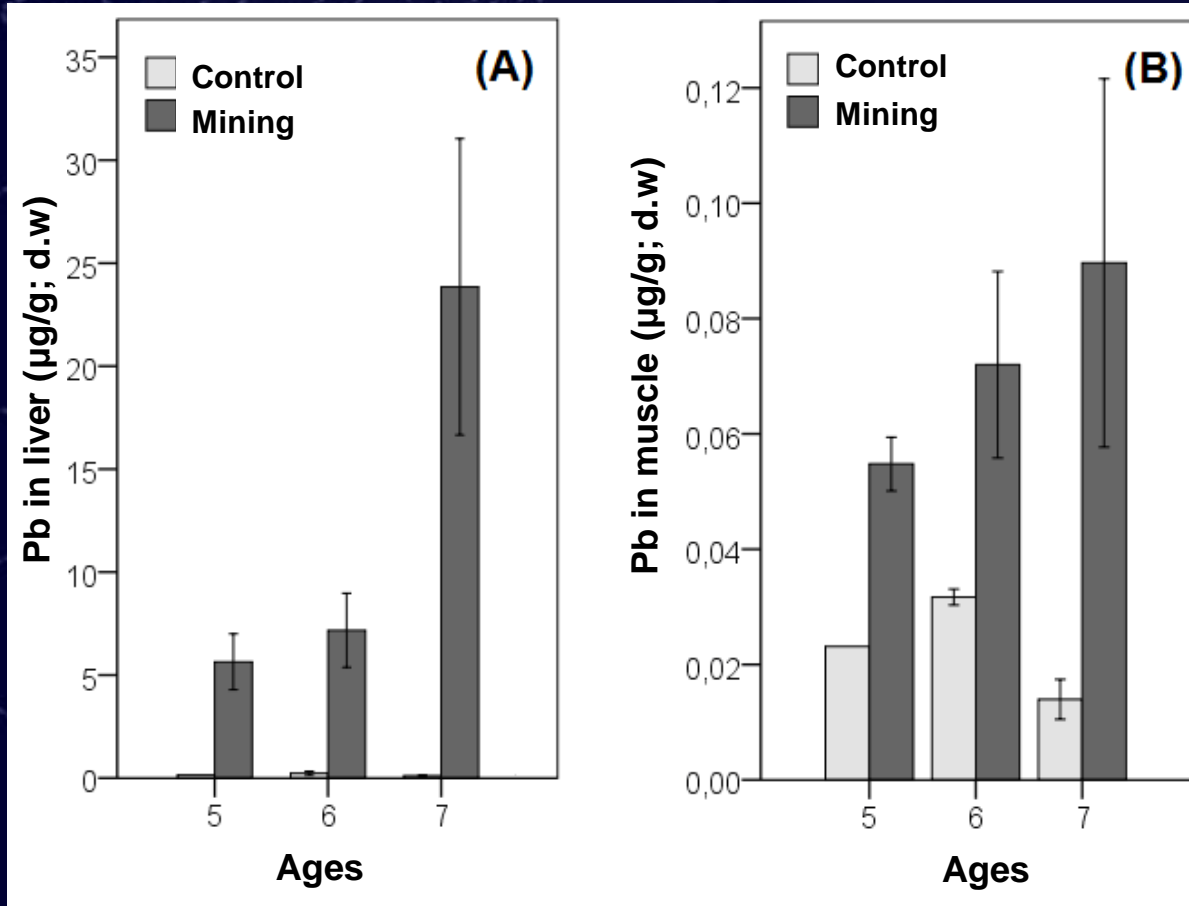
All samples (all adult females) <EU MRL

Lambs or rams?



Pb levels in muscle by sampling site

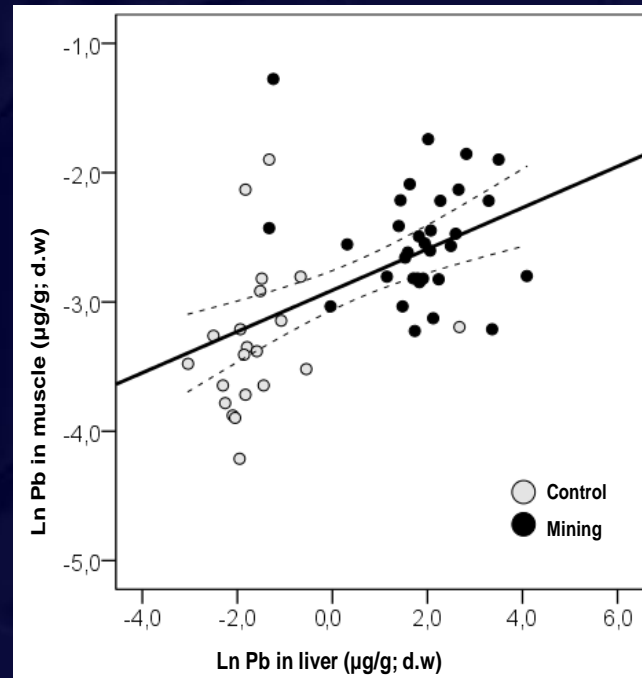
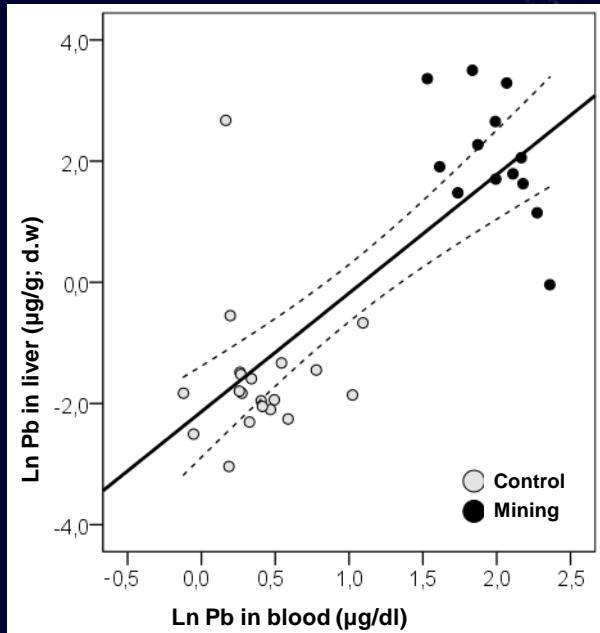
Results and Discussion



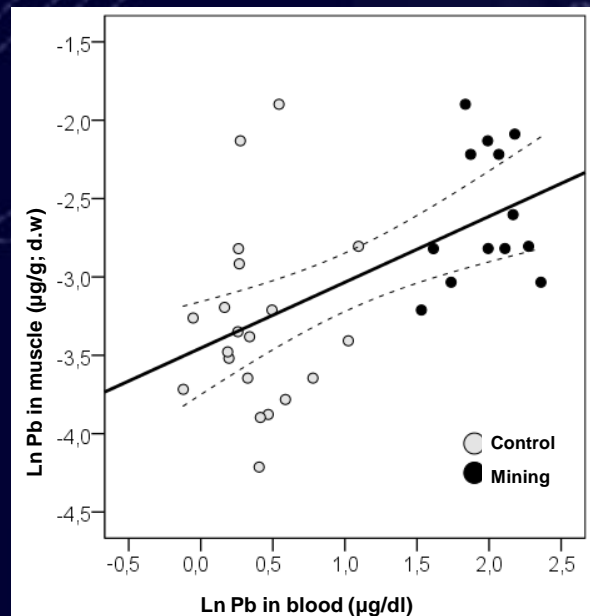
Relation between Pb levels in liver and muscle with the age.

Age: Non-significant

Results and Discussion



Linear correlations (+), but completely determined by the zone factor.



Conclusions

1. Sheep from the mining district of Alcudia Valley and Sierra Madrona have blood and liver Pb levels indicative of a chronic exposure to the Pb contamination persisting in the area. These Pb levels are high enough to be considered as a health risk for the livestock.
2. Pb levels in the muscle of the adult sheep from the mining area, despite of being higher than the controls, did not exceed the limit set by the EU for meat.
3. The results of this project highlight the need to 1) increase surveillance for exposure of livestock to Pb contamination in mining polluted sites and 2) adopt measures to minimize the exposure of livestock to such mining pollution by appropriate management of highly polluted soils and the restriction of access for livestock to these sites.

THANK YOU

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