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TOXICOLOGICAL BIOASSAYS TO EVALUATE THE EFFECTIVENESS OF A DECONTAMINATION TECHNIQUE FOR ARSENIC CONTAMINATED WATERS

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Departament of Soil Science and Agricultural Chemistry. University of Granada.

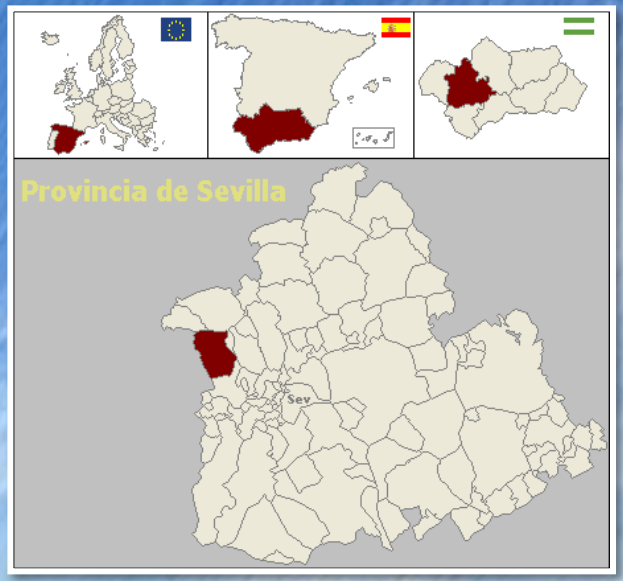
INDEX.

INTRODUCTION.

Fuente: El Confidencial

MINE WASTEWATERS

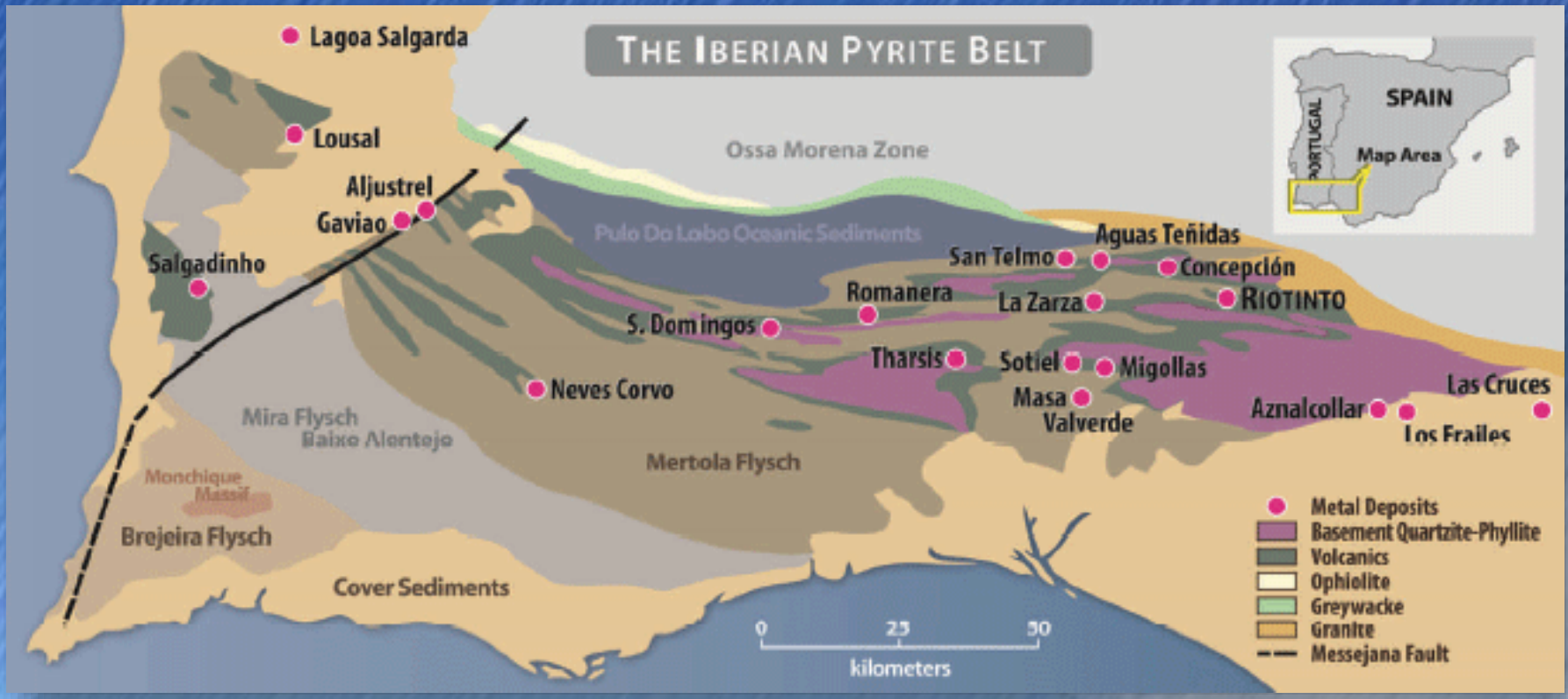
As Ni
Cd Cu
Pb ...



Autor: Lo Guilhem.

INTRODUCTION.

In Spain, the mining industry in...



Fuente: IGME

POTENTIAL FOCUS OF CONTAMINATION BY MINE WASTEWATERS

INTRODUCTION.

IT IS NECESSARY TO HAVE EFFECTIVE DECONTAMINATION TECHNIQUES
FOR...

- Prevent the deterioration of the environment
- Avoid exposure to contamination of living beings.

THERE ARE SEVERAL DECONTAMINATION TECHNIQUES. BUT IN THIS WORK, PEATLAND SOILS ARE USED AS A DECONTAMINATION TECHNIQUE FOR CONTAMINANTED WATERS BY ARSENIC.

INTRODUCTION.

WHY ARSENIC CONTAMINATED WATERS?

INTRODUCTION.

WHY PEATLAND SOILS?

INTRODUCTION.

WHY ARSENIC CONTAMINATED WATERS?

BECAUSE...

- ❑ Represents a serious problem for human health.
  - ✓ It is carcinogenic (Group 1 of IARC Categories)
  - ✓ It have a high toxic potential.
- ❑ Causes alterations in the ecological equilibrium.
- ❑ Water pollution by arsenic affects more than 150 million people, mainly in Asian countries. (Singh et al., 2015)

INTRODUCTION.

WHY PEATLAND SOILS?

BECAUSE...

- Peatland soils have the adsorption capacity of metals and metaloids. (González et al., 2006); (Palmer et al., 2015)

INTRODUCTION.

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Efficient removal of arsenic, antimony and nickel from mine wastewaters in Northern treatment peatlands and potential risks in their long-term use

Katharina Palmer *, Anna-Kaisa Ronkanen, Bjørn Kløve

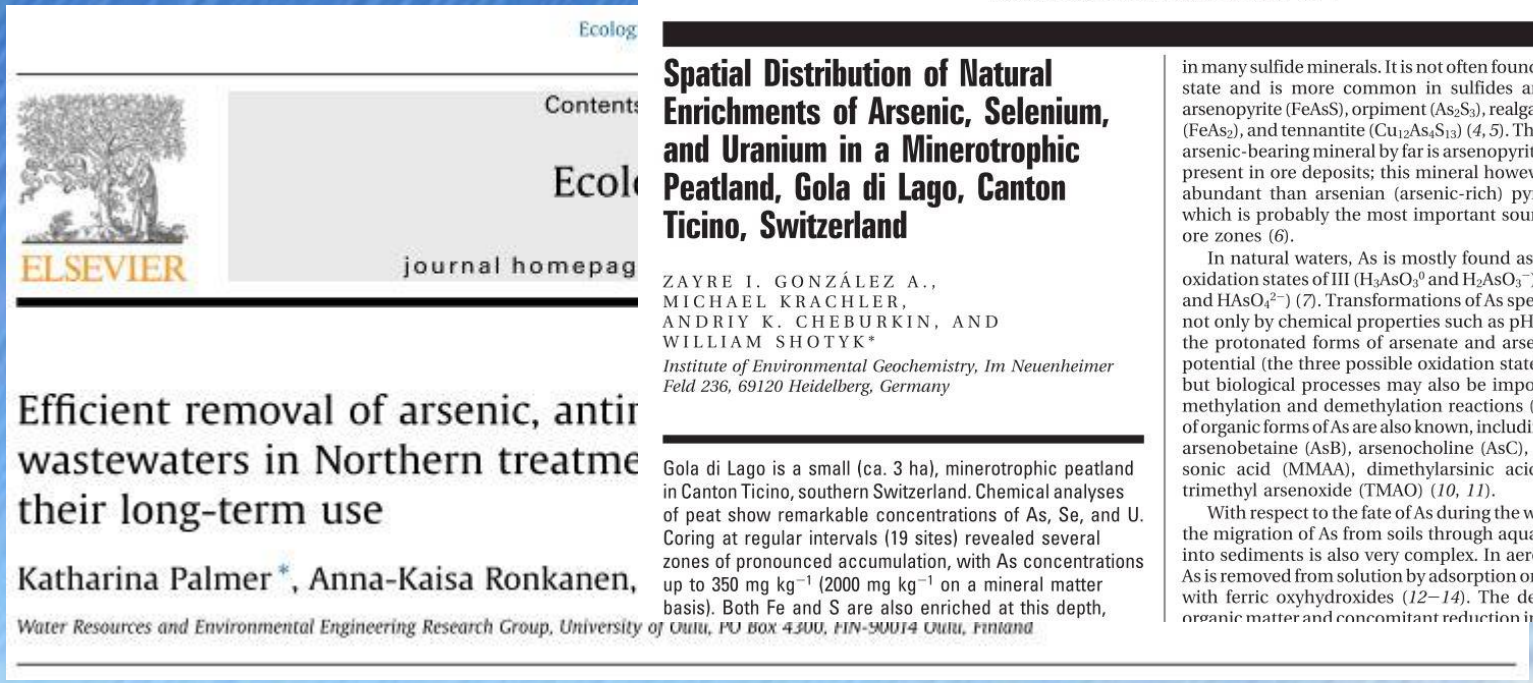
Water Resources and Environmental Engineering Research Group, University of Oulu, PO Box 4300, FIN-90014 Oulu, Finland

INTRODUCTION.

WHY PEATLAND SOILS?

BECAUSE...

- Peatland soils have the adsorption capacity of metals and metaloids. (González et al., 2006); (Palmer et al., 2015)



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Efficient removal of arsenic, antir
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Environ. Sci. Technol. **2006**, *40*, 6568−6574

Spatial Distribution of Natural Enrichments of Arsenic, Selenium, and Uranium in a Minerotrophic Peatland, Gola di Lago, Canton Ticino, Switzerland

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Gola di Lago is a small (ca. 3 ha), minerotrophic peatland in Canton Ticino, southern Switzerland. Chemical analyses of peat show remarkable concentrations of As, Se, and U. Coring at regular intervals (19 sites) revealed several zones of pronounced accumulation, with As concentrations up to 350 mg kg^{-1} (2000 mg kg^{-1} on a mineral matter basis). Both Fe and S are also enriched at this depth,

in many sulfide minerals. It is not often found in its elemental state and is more common in sulfides and sulfosalts as arsenopyrite (FeAsS), orpiment (As_2S_3), realgar (AsS), lollingite ($FeAs_2$), and tennantite ($Cu_{12}As_4S_{13}$) (*4*, *5*). The most common arsenic-bearing mineral by far is arsenopyrite, which is often present in ore deposits; this mineral however, is much less abundant than arsenian (arsenic-rich) pyrite [$Fe(S, As)_2$], which is probably the most important source of arsenic in ore zones (*6*).

In natural waters, As is mostly found as oxyanions with oxidation states of III ($H_3AsO_3^0$ and $H_2AsO_3^-$) and V ($H_2AsO_4^-$ and $HAsO_4^{2-}$) (*7*). Transformations of As species are affected not only by chemical properties such as pH (dissociation of the protonated forms of arsenate and arsenite) and redox potential (the three possible oxidation states noted above), but biological processes may also be important, including methylation and demethylation reactions (*8*, *9*). A number of organic forms of As are also known, including arsenosugars, arsenobetaine (AsB), arsenocholine (AsC), monomethylarsonic acid (MMAA), dimethylarsinic acid (DMAA), and trimethyl arsenoxide (TMAO) (*10*, *11*).

With respect to the fate of As during the weathering cycle, the migration of As from soils through aquatic systems and into sediments is also very complex. In aerobic conditions, As is removed from solution by adsorption or coprecipitation with ferric oxyhydroxides (*12*−*14*). The decomposition of organic matter and concomitant reduction in redox potential

INTRODUCTION.

WHY PEATLAND SOILS?

Horizons of a peatland soil from the peatbog of Padul (Granada) are used to reduce As concentration in water.

Fuente: Turbera del Agia.

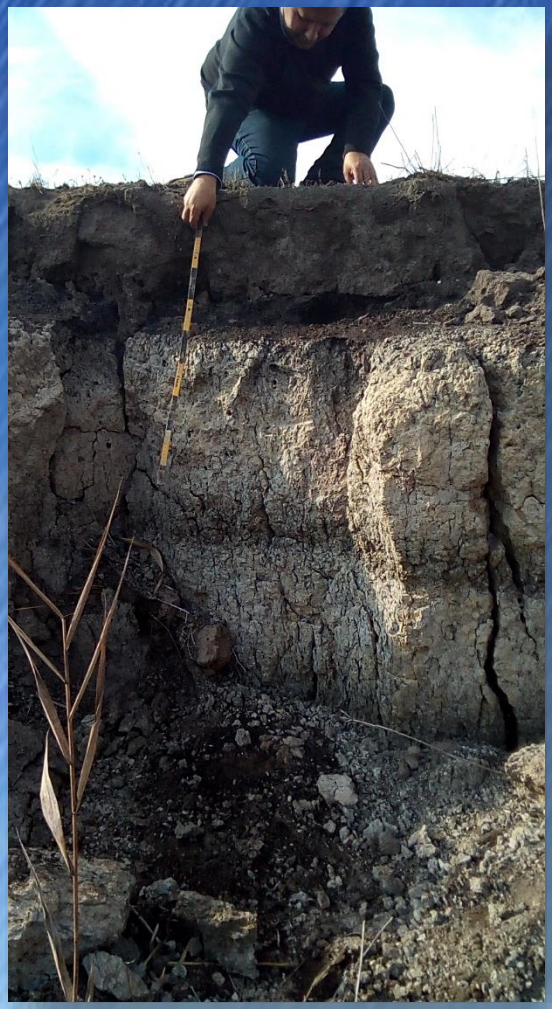
AIMS.

- Determine the capacity of arsenic adsorption by horizons of the peatland soil.
- Evaluate the remedial effectiveness of this decontamination technique by toxicological bioassays which measure the degree of toxicity in water and soil.

MATERIALS.

DECONTAMINATION TECHNIQUE.

What is the capacity of arsenic adsorption by the horizons of the terric Histosol?



Fuente: Aguilar Garrido, A.

Fuente: Agencia de Medio Ambiente y Agua.

Fuente: Aguilar Garrido, A.

MATERIALS.

DECONTAMINATION TECHNIQUE.

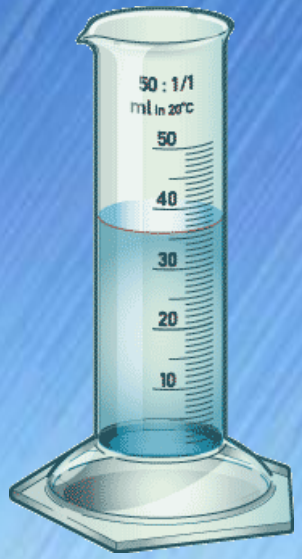
What is the decontamination technique experience?

30 g 

Histic horizon (Peat) → T

Carbonated horizon → S

+

150 ml 

Polluting solutions of an arsenate salt

- 0 µg As/l - Control
- 50 µg As/l
- 100 µg As/l
- 200 µg As/l

Fuente: Aguilar Garrido, A.

MATERIALS.

DECONTAMINATION TECHNIQUE.

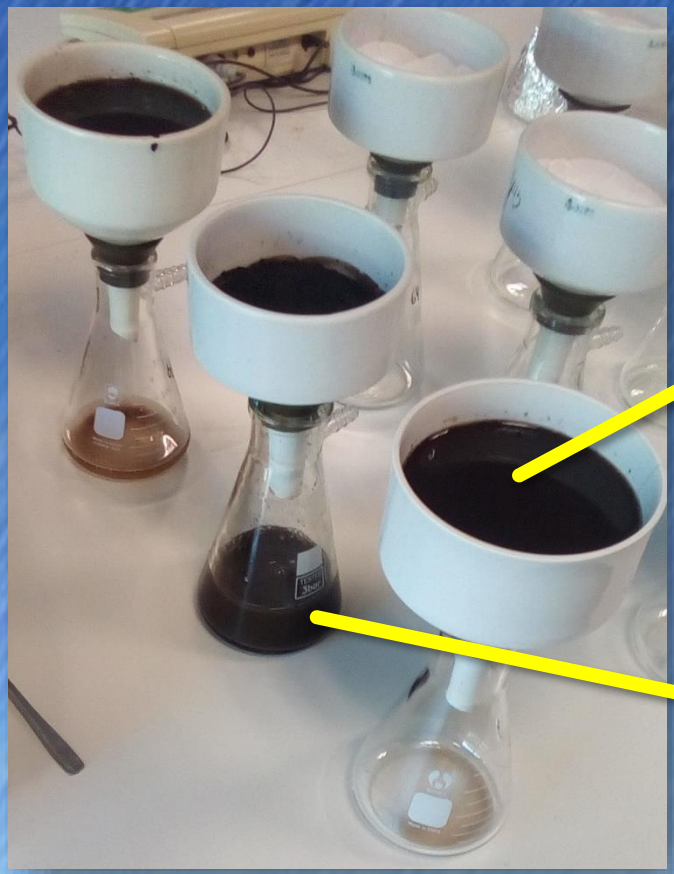
What is the decontamination technique experience?

Fuente: Aguilar Garrido, A.

MATERIALS.

TOXICOLOGICAL BIOASSAYS.

How evaluate the effectiveness of the decontamination technique?



Fuente: Aguilar Garrido, A.

SOIL

Fuente: Aguilar Garrido, A.

LEACHATE

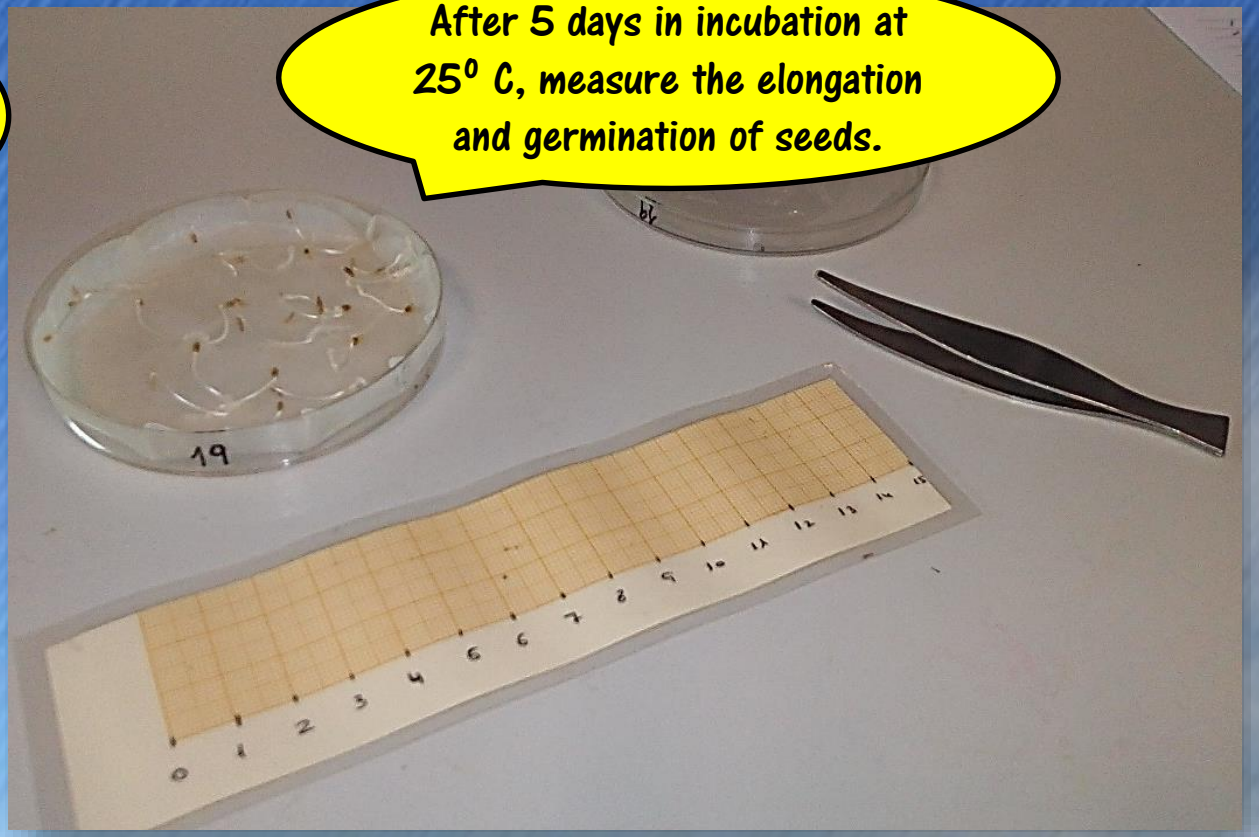
Fuente: Aguilar Garrido, A.

MATERIALS.

TOXICOLOGICAL BIOASSAYS.

Root germination and elongation of common lettuce (*Lactuca sativa*) bioassay. (OECD, 2003)

Fuente: Aguilar Garrido, A.

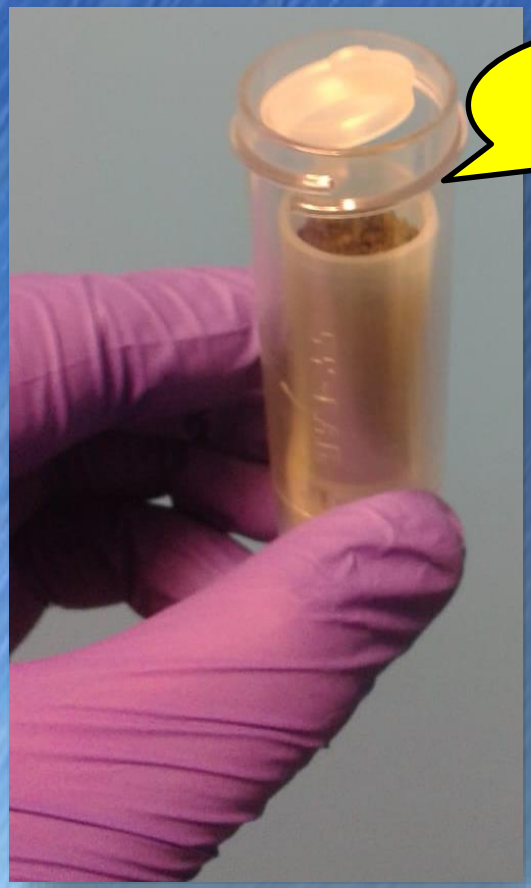


Fuente: Aguilar Garrido, A.

MATERIALS.

TOXICOLOGICAL BIOASSAYS.

Soil respiration bioassay. (ISO 17155, 2002)



5 g soil + KOH solution (2%)

4 days at 30º C

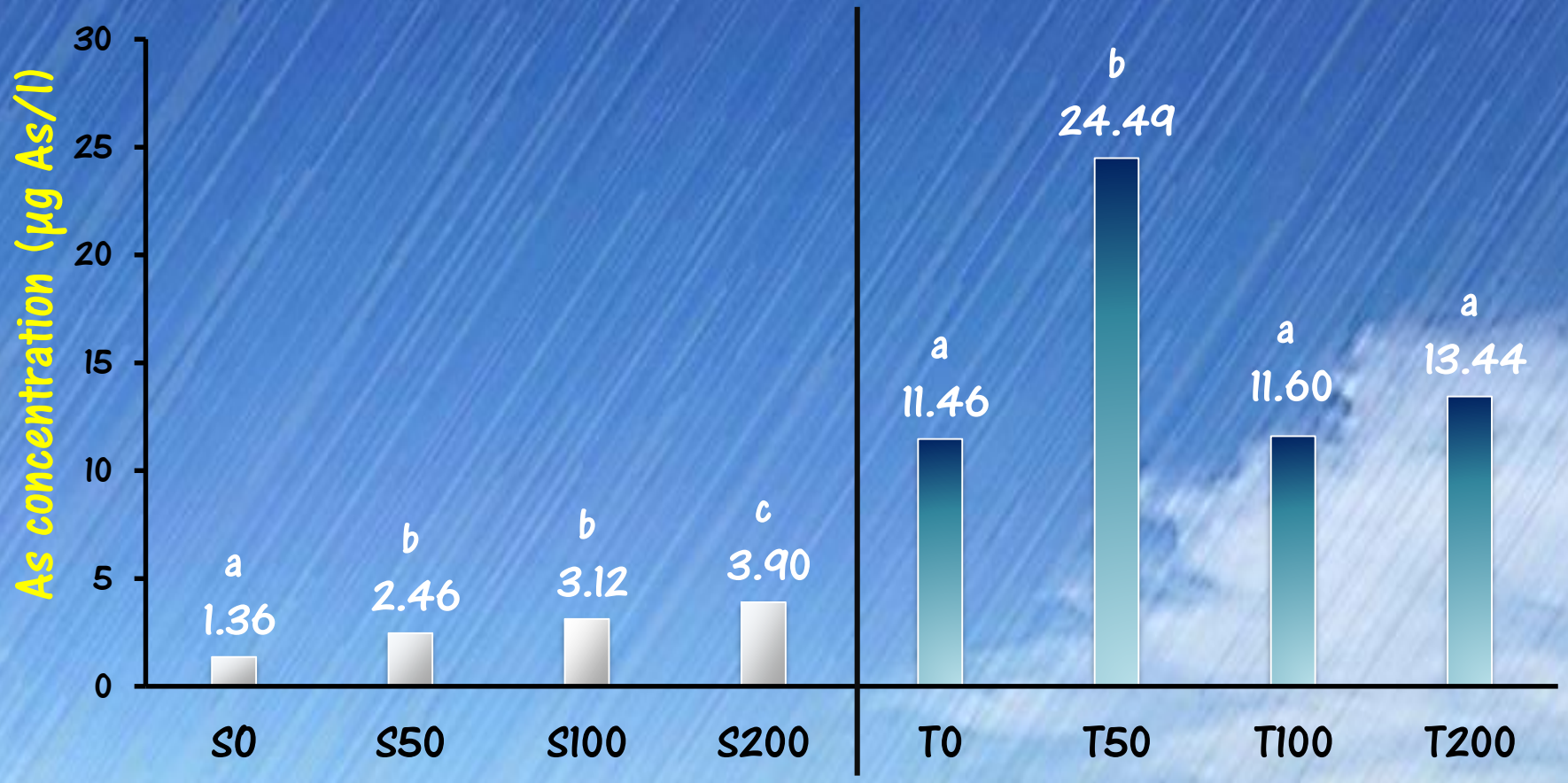
BacTrac 4200 microbiological analyzer

Fuente: Aguilar Garrido, A.

Fuente: Aguilar Garrido, A.

RESULTS AND DISCUSSION.

ARSENIC CONCENTRATION IN THE LEACHATE AFTER THE WATER DECONTAMINATION EXPERIENCE.

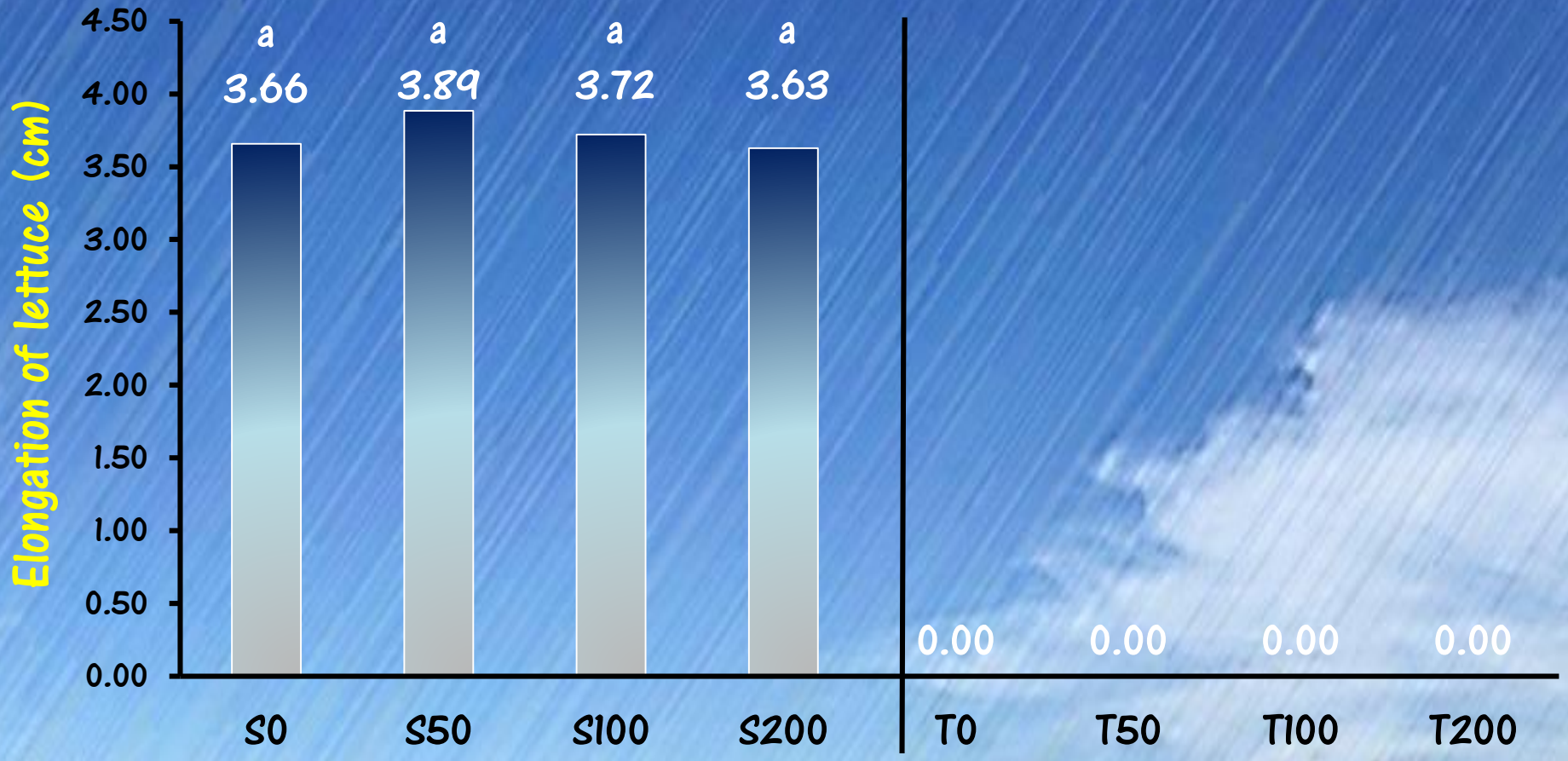


S – Carbonated horizon, T – Histic horizon

Treatments: 0 (control), 50, 100, 200 µg As/l

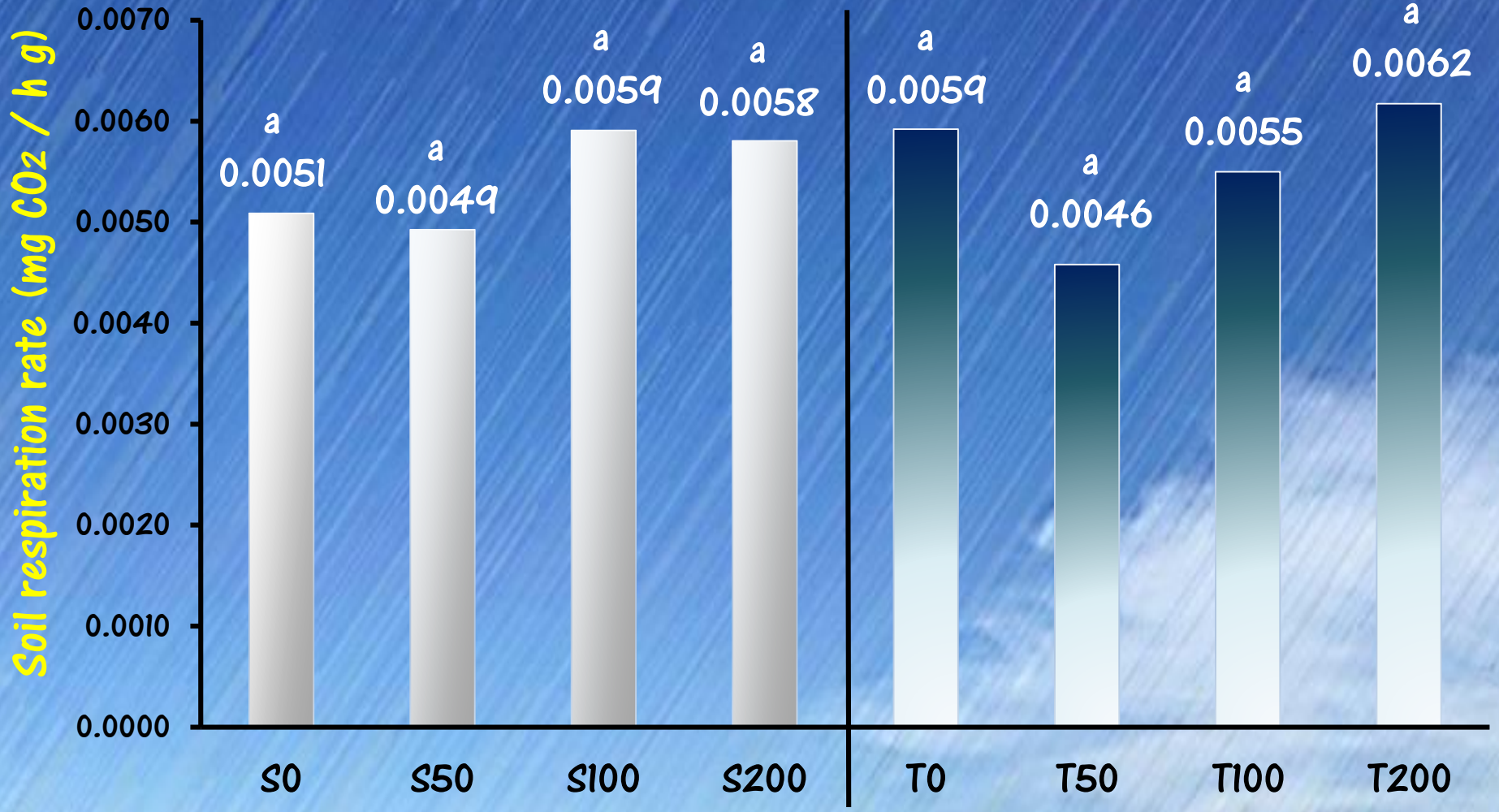
RESULTS AND DISCUSSION.

ROOT GERMINATION AND ELONGATION OF LETTUCE BIOASSAY.



RESULTS AND DISCUSSION.

SOIL RESPIRATION BIOASSAY.



S – Carbonated horizon, T – Histic horizon

Treatments: 0 (control), 50, 100, 200 µg As/l

CONCLUSIONS.

1. Both histic and carbonated horizons have the ability to adsorb As since the reductions in As concentration are higher than 90% in most cases.
2. These bioassays should consider all physico-chemical properties when determining the effectiveness of the decontamination technique based in the use of peatland soils, as the reduction of the concentration is not reflected on the bioassays.
   - 2.1. In the case of root germination and elongation of lettuce bioassay, because the inhibition in germination of lettuce seeds is directly related to the acidity of the water in contact with the histic horizon, instead of the concentration of arsenic.
   - 2.2. In the case of soil respiration bioassay, because the soil respiration has a low sensitivity to arsenic contamination.
3. The decontamination technique based on the use of peatland soil is effective. Because the reduction in the concentration of As is high, although the bioassays do not show it.

Thank you so much for your attention.

"Soil is an essential component of the environment in which life develops".

World Soil Charter (FAO, 1982)