Valorisation of Mining Areas Using Phytotecnologies – a Field Experiment

Alberto Vega[1], Helena Moreira[1], Sofia I.A. Pereira[1], Paula Ávila[2], Adelaide Ferreira[2], Carla Candeias[3,4], Paula M.L. Castro[1]

[1] CBQF - Centro de Biotecnologia e Química Fina – Laboratório Associado, Escola Superior de Biotecnologia - Universidade Católica Portuguesa/Porto
[2] LNEG - National Laboratory of Energy and Geology
[3] ISPUP – Institute of Public Health of the University of Porto; [4] GeoBioTec – Geobiosciences, Geotechnologies e Geoengineering Research Center, Geosciences Department, University of Aveiro

[1]hgmoreira@porto.ucp.pt; [1]sapereira@porto.ucp.pt; [1]avega@porto.ucp.pt; [2]paula.avila@lneg.pt; [1]plcastro@porto.ucp.pt

CATÓLICA
CBQF - CENTRE FOR BIOTECHNOLOGY AND FINE CHEMISTRY ASSOCIATE LABORATORY CBQF
PORTO

Introduction

Mining operations are one of the major soil disruptors. The release of hazardous compounds, such heavy metals and metalloids (HM), pose serious risks to human health and contribute to the decline of soil's quality. Phytotechnologies (application of plants and microorganisms) have the potential for reducing the amount and/or toxicity of deleterious HM, promoting ecological restoration. Moreover, they can provide relevant economic revenues by using these brownfields to produce bioenergy crops.

The PhytoSUDOE project, which harbors this work, aims to boost the environmental, economical and social benefits generated through the implementation of phytotechnologies in degraded sites. For that purpose a transnational network of 11 contaminated sites distributed through Portugal, Spain and France (i.e the SUDOE region) was established to demonstrate sustainable remediation strategies.

Objectives

The Borralha mine is a deactivated tungsten producer in Portugal, and is one of the target sites of the PhytoSUDOE project. The soils have high HM concentrations (e.g. Cu and Cd) and could benefit from the application of phytotechnologies for its recovery while producing crops with further value. In this context, the main goals of this work are:

•to evaluate the contamination of the site;
•to evaluate the growth of bioenergy crops (e.g. sunflower) assisted by arbuscular mycorrhizal fungi (AMF);
•to assess sunflower's phytostabilization capacity.

Methods

BORRALHA MINE DESCRIPTION AND LOCATION

- Borralha mine (1179 ha): 1902-1986;
- Economic exploitation: wolframite, scheelite, chalcopyrite;
- Sources of contamination:
  (a) tailings,
  (b) mud and slush, rejected from the ore process treatment, discharged into a pond;
  (c) sulphides directly deposited into the ground.

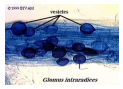
EXPERIMENTAL DESIGN

C1	T1
T2	C2
C3	T3

Control (C)
- 3 plots (9 m²)

Treatment (T)
- 3 plots (9 m²)
- Inoculation with AMF

Inoculation at sowing



PLOTS ANALYSIS (on-going)

Assessment of HM Concentration in the Soil

Sample collection

HM (mg kg⁻¹)	C1	C2	C3	T1	T2	T3	Tier 1 Guideline
Cd	7	3	3	3	4	3	1
Co	22	14	15	12	15	31	20
Cr	55	23	21	20	21	27	64
Cu	1433	850	780	615	754	1407	63
Ni	37	21	15	16	17	18	45
Pb	212	118	102	75	110	75	70
Zn	323	256	113	119	114	124	200
As	35	37	59	33	28	66	17

Colored Values indicate concentrations above the Tier 1 guideline value.

- High HM contamination, mainly with Cu, Cd, Pb and As.
- Heterogeneity of contamination over the plots.

Establishment of Sunflower and Plant Analysis

Seed sowing

Plant Growth

Plant Harvesting

Biomass Assessment

Grinding

Grinded Plants

Soil

Sunflower (Rhizos. Soil)
- HM Bioavailability
- Rhizosphere community

Sunflower (Plants)
- HM content
- BCF/TF
- Nutrient Content

Sunflower was able to establish and grow in spite of the high HM concentrations in the soil.

On-Going Work

- Sunflower was harvested in October and rhizospheric soil samples were collected to determine the metal bioavailability.
- Biomass, elongation and metal content in each plant section (root and shoots) will be assessed.
- Bioconcentration and translocation factors will be determined to assess the plant phytostabilization/phytoextraction abilities.
- Soil analysis to determine structural and functional microbial diversity will be performed at the end of the experiment.

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