Phytostabilization of Neutral Mine Tailings within the San Pedro River National Conservation Area in southern Arizona

Boston Mill mine tailings site, Arizona

General Background

The legacy of mining in Arizona is waste rock and mine tailings that contain a variety of toxic metals including **arsenic, lead, and cadmium**. In arid and semi-arid portions of the western U.S. spreading of these metal toxicants occurs through a combination of wind and water erosion resulting in measured elevated levels in ecosystems that are even significant distances from the tailings site. Current UA SBRP research is investigating easy, low-cost ways to revegetate mine tailings with native plants with the least amount of site preparation, fertilizer and maintenance. Phytostabilization would replace traditional methods such as removing or disposing of the tailings or capping with either clay or asphalt.

Site and Project Description

The Boston Mill mine tailings site is adjacent to the San Pedro River in southern Arizona. An 18-month revegetation trial was conducted at the Boston Mill site to evaluate the growth of a salt and drought-tolerant plant species, fourwing saltbush (*Atriplex canescens*) **with and without compost addition in a neutral pH site.**

Field Trial Conditions

- Boston Mill is a 100-acre site
- Mined for gold and silver from 1879 - 1887
- Metal concentrations:
  - = Lead (→ 20,000 mg/kg) Arizona Soil Remediation Levels = 1200 mg/kg
  - =Arsenic (→ 10 mg/kg)
  - = Cadmium (→ 100 mg/kg)
  - = Copper (→ 6,000 mg/kg)
  - = Zinc (→ 20,000 mg/kg)
- Heterotrophic bacterial counts low (~10^5 CFU/g)

Microbial community analysis indicates a moderate level of disturbance

Image 1. Wind erosion of a mine tailings pile in a typical semi-arid environment.

Image 2. Evidence of water erosion of mine tailings adjacent to the San Pedro River, Arizona.

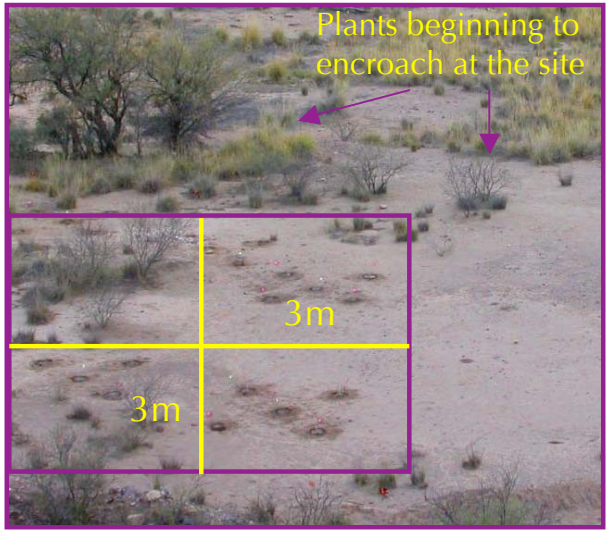


Image 3. Transplants were planted in a series of 3 x 3 m plots that were established in quadruplicate on the test site to evaluate growth alone or with compost addition.

Results

The results of the initial trial indicated that native plants may be established on the Boston Mill tailings site without addition of organic matter or fertilizer amendments. More than 80% of *Atriplex* transplants survived after 1.5 years in both compost and no compost treatments. For the single plant studied, four-wing saltbush, Al, As, Cd, Cu, Fe, Hg, Mn, and Zn metal uptake into shoot tissues did not exceed recommended guidelines with the exception of Pb.

Image 3. Close-up of a transplanted *Atriplex lentiformis* seedling.

Image 4. Successful establishment of *Atriplex lentiformis* 9 months after transplantation.

80% of transplants survived

Biomass increased significantly

No difference between compost/no compost treatments in neutral tailings

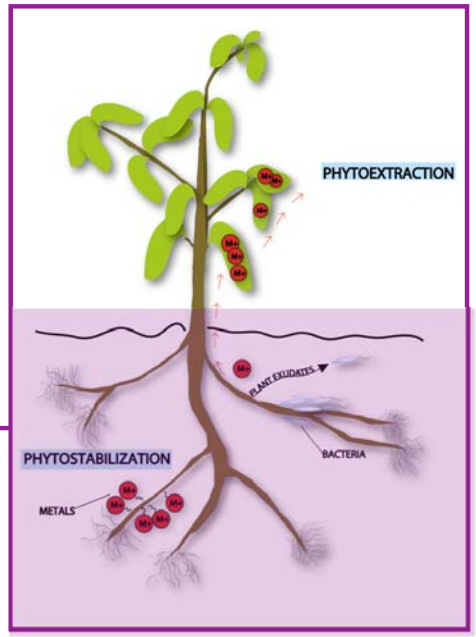
Bacterial community monitored to indicate plant and soil health

Sustainability

Phytostabilization promotes the conversion of tailings into soil material and ecological succession. This results in a more stable site in terms of leaching and erosion processes. In comparison with capping which may fail with time, stability following successful phytostabilization improves with time. Further, there is no moving, disposing or importing of resources (clay or pavement) except for plants themselves.

Next Steps

The Bureau of Land Management has granted funds to continue phytostablilization efforts at the Boston Mill mine tailings site adjacent to the San Pedro River. This time a native seed mixture including *Atriplex lentiformis* (quailbush) will be applied to establish a vegetative cover on 1.5 acres at the site. The location will be monitored for two years following seeding to measure growth and to determine shoot metal uptake in selected plants.



Schematic 1. Phytoremediation options. Phytoextraction is used to remove contaminants from soil or sediment by having plants take them up and store them in above ground, harvestable tissues. Phytostabilization, is the use of plants to immobilize contaminants in the soil.

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