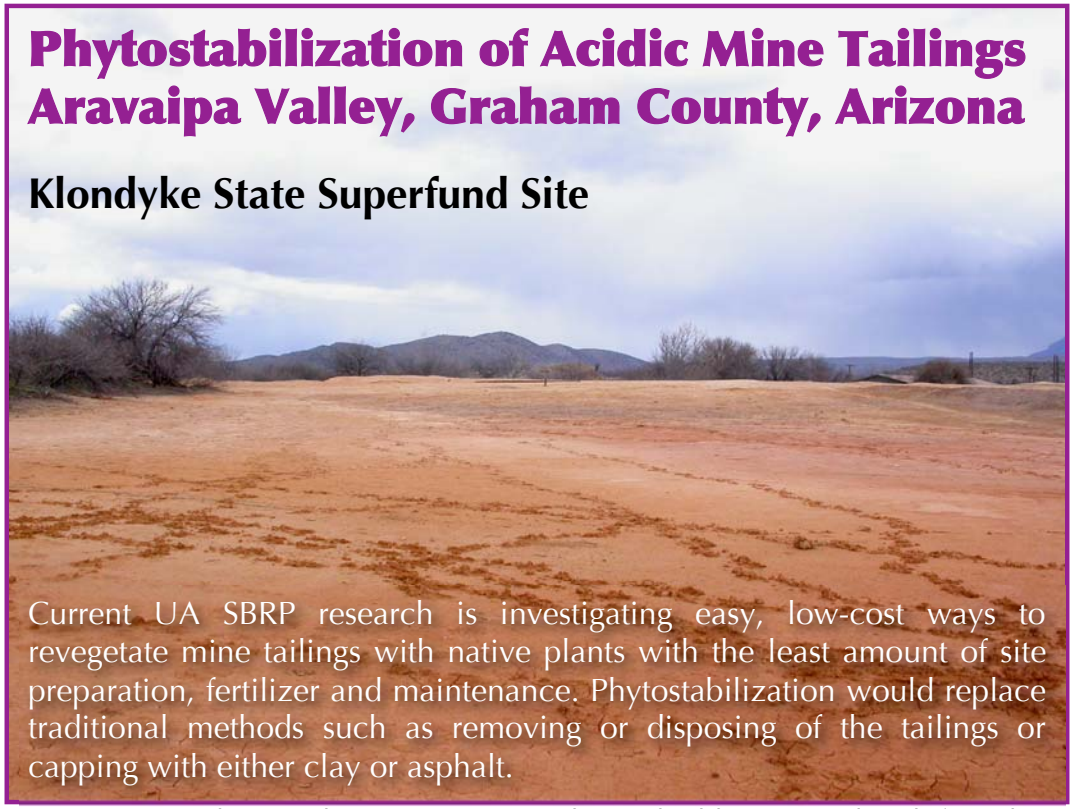
Phytostabilization of Acidic Mine Tailings Aravaipa Valley, Graham County, Arizona

Klondyke State Superfund 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.

Image 1. A mine tailing site adjacent to Aravaipa Creek near Klondyke, Arizona, devoid of any plant life. Mine tailings here have the consistency similar to flour.

Project Description

In a greenhouse study using a native, salt and drought tolerant plant species quailbush, *Atriplex lentiformis* germination, growth and metal uptake was evaluated using two Klondyke mine tailing samples at pH 3 and pH 6, amended with 25%, 15%, 10%, 5% and 0% compost to determine the:

1) Minimum level of compost required for establishment of quailbush in lead-zinc tailings via seed germination and seedling growth

2) Metal accumulation in shoot tissue during growth of quailbush

3) Impact of plant establishment on microbial community measured by the number of autotrophic and heterotrophic bacterial communities before and after planting.

Site Description

The Klondyke mill site is located on the eastern bank of Aravaipa Creek in the transition zone between the riparian corridor and the semiarid uplands in the Aravaipa Valley, Graham County, Arizona. This Pb and Zn ore processing operation from 1948 to 1958 disposed of ~100,000 tons of floatation tailings that have remained devoid of vegetation. In addition, elevated levels of Cd and Pb were found in fish sampled from Aravaipa Creek downstream from the mine tailing site.

Field Trial Conditions

- pH ranges from 2 to 6
- 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 counts low (< 100 CFU/g)
- Autotrophic (iron and sulfur oxidizers) counts 10^4 to 10^5 CFU/g

Microbial community analysis indicates level of disturbance

Image 2. A side by side comparison illustrating similar total biomass of *A. lentiformis* grown in Klondyke mine tailings amended with 15% compost at pH 3 and the compost control.

Sustainability

Phytostabilization promotes the conversion of tailings into soil material and ecological succession. In addition, this is much more stable in terms of leaching and erosion processes could occur with traditional capping. There is no moving, disposing or importing of resources (clay or pavement) except for plants themselves.

Results

With compost amendment, quailbush has good potential as a native species candidate for phytostabilization of mine tailings in semiarid environments.

The study determined:

1. 10 % and 15% - Minimum level of compost required
2. No accumulation of Pb, Cu, Cd, and As in shoot material
3. Compost addition **increased**:
   - pH
   - Nutrients
   - Heterotrophic counts
4. Microbial community analysis indicates level of disturbance. Initially, autotrophic populations estimates were four to six logs higher than heterotrophic counts, indicating extremely stressed conditions. However, post-harvest, heterotrophic bacterial counts increased to normal levels (~10^6 CFU g^{-1}dry tailings) and dominated the rhizosphere.

The zone surrounding the roots of plants in which complex relations exist among the plant, the soil microorganisms and the soil itself.

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