USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Rocky Mountain Research Station
USDA Northwest Climate Hub

# Black to the Future: Biochar and Forests

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## Mining for Answers: Using biochar to remediate abandoned mine lands

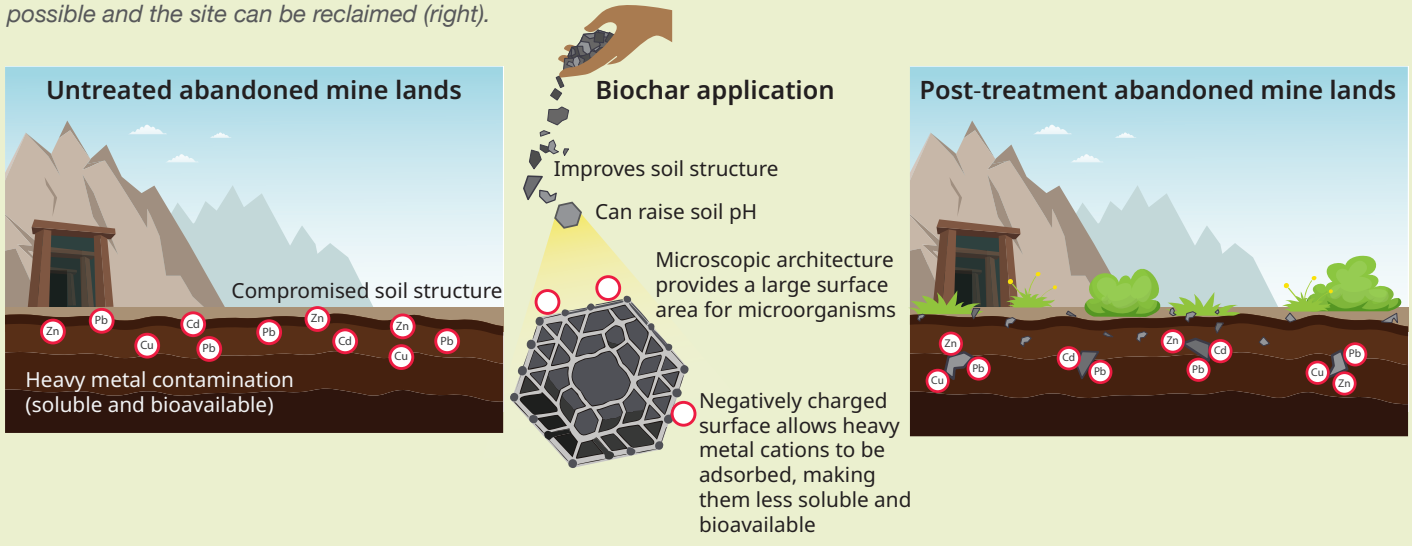
The mining and extraction of metals, natural gas, and oil helped propel population movement, technology, and wealth, but the boom and bust of mining left behind thousands of abandoned mines on public lands. Many abandoned mine sites pose environmental and human health concerns, including physical risks like open holes, contaminated soil, degraded water quality, and poor native plant revegetation. One tool for remediating degraded soil is to incorporate biochar in the mine spoils. Biochar is a carbon-rich soil amendment created by burning slash with specifically designed equipment at relatively low temperatures. Biochar added to disturbed or contaminated soil can bind and neutralize harmful chemical compounds, reduce acidity, and improve soil water availability, thereby helping to promote the establishment and success of native vegetation. The biochar needed to restore abandoned mine sites can be made during forest restoration activities nearby. Mobile biochar technologies (*e.g.*, CharBoss ® air curtain incinerator, kilns) make the forest-to-mine site efforts an affordable solution. Biochar created from forest slash can be applied to nearby abandoned mine land (AML) sites.

### How biochar works to remediate mine lands

Many abandoned mine sites generate acidity which increases metal solubility. These two factors work to degrade local soil properties and processes. Biochar often has a high pH, and thus can help to reduce soil acidity in the short-term. Higher soil pH reduces metal transport in both soil and water. Some mine sites are completing lacking in vegetation because of elevated bioavailable metals.

### Remediating mine soils with biochar

*Prior to treatment, mine soils are contaminated with heavy metals from previous mining activities (left). Once biochar is applied to these soils, it binds the heavy metals in the soils and can improve overall soil health (middle). After treatment, revegetation is possible and the site can be reclaimed (right).*



Not all abandoned mine sites are contaminated. On sites where there is no contamination, biochar works to improve soil conditions to allow plants to get established. On all abandoned mine soils there is usually some combination of poor soil structure, low water storage or plant available water, limited nutrient cycling, low pH, and persistent heavy metals, which often lead to erosion, leaching, polluted water ways, and poor revegetation. Applying wood-based biochar can immobilize heavy metals, reduce bioavailability, improve water retention capacity and quality, decrease soil erosion, and promote vegetation establishment— thus, helping to restore these lands.

## Benefits of Biochar

| Soil Property | Biochar Benefits |
|---|---|
| Low pH (acid soil) | Increases pH by acting as a liming agent |
| Low positive and negative exchange sites | More exchange sites to adsorb heavy metals |
| Low porosity | Increases infiltration and water storage |
| High bulk density | Reduces compaction |

## Choosing the correct biochar

When using biochar to remediate contaminated mine lands it is important to match the properties of biochar with the needs of the site, especially the soils. It is also critical to understand the type of biochar and the heavy metal contamination conditions for each mine site. This will guide application rates. It will also save time and money during the reclamation process and can help prediction of the outcomes. Some mine soils might need an activated biochar product that has increased ion exchange sites. Other soils might need the buffering capacity of biochar to reduce acidity, while others would benefit from a biochar that is high in ash content to sequester metals (*e.g.,* Cu and Zn).

If the soil is not contaminated, then biochar created from local trees will be sufficient to promote changes in soil properties to get vegetation established. For example, many mine soils are acidic (pH <7) and many soft wood-based biochars are alkaline (pH >7), making this soil-biochar mix a good fit to get vegetation established.

Biochar is a long-term soil amendment and, therefore, safe application rates should be considered for degraded soil. Mine spoils generally have a low organic matter content (<1%). Ideally, the amount of biochar added would bring the amount of organic matter up to 2%, but the most productive soils have an organic matter content of 3-6%. Although biochar is different from soil organic matter, it helps promote root growth and microbial activity that add to the organic matter pool. There are no hard and fast rules for how much to apply. Generally, the rates range from 1 to 50 tons/acre, and it is important to consider the initial soil properties and the targeted range of properties necessary to promote vegetation.

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**The Northwest Climate Hub serves Alaska, Idaho, Oregon, and Washington by delivering science-based, region-specific technologies and practical information that will assist with climate-informed decision making.**

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## FURTHER READING

Rodriguez-Franco, Carlos; Page-Dumroese, Deborah S. 2021. Woody biochar potential for abandoned mine land restoration in the U.S.: a review. Biochar. 3(1): 7-22. https://doi.org/10.1007/s42773-020-00074-y.