USDA

BIOCHAR

Opportunities for Biochar to Remediate Forest Soils in Abandoned Mine Lands

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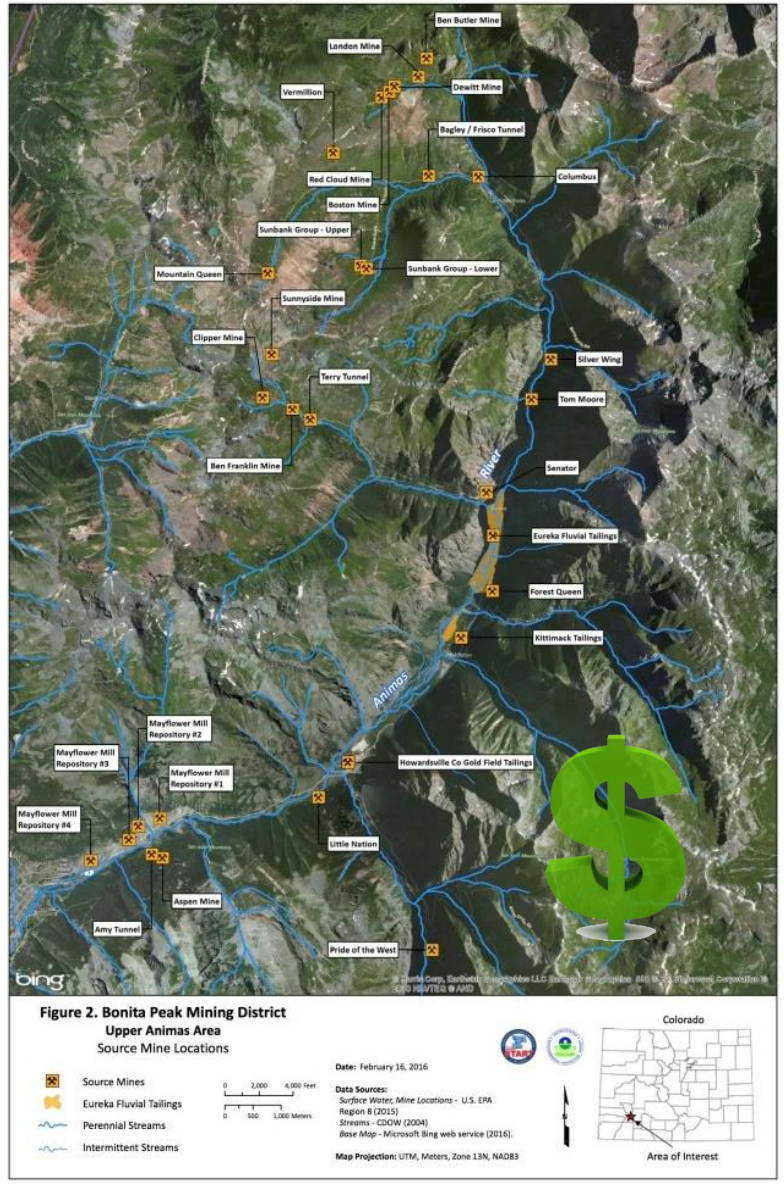
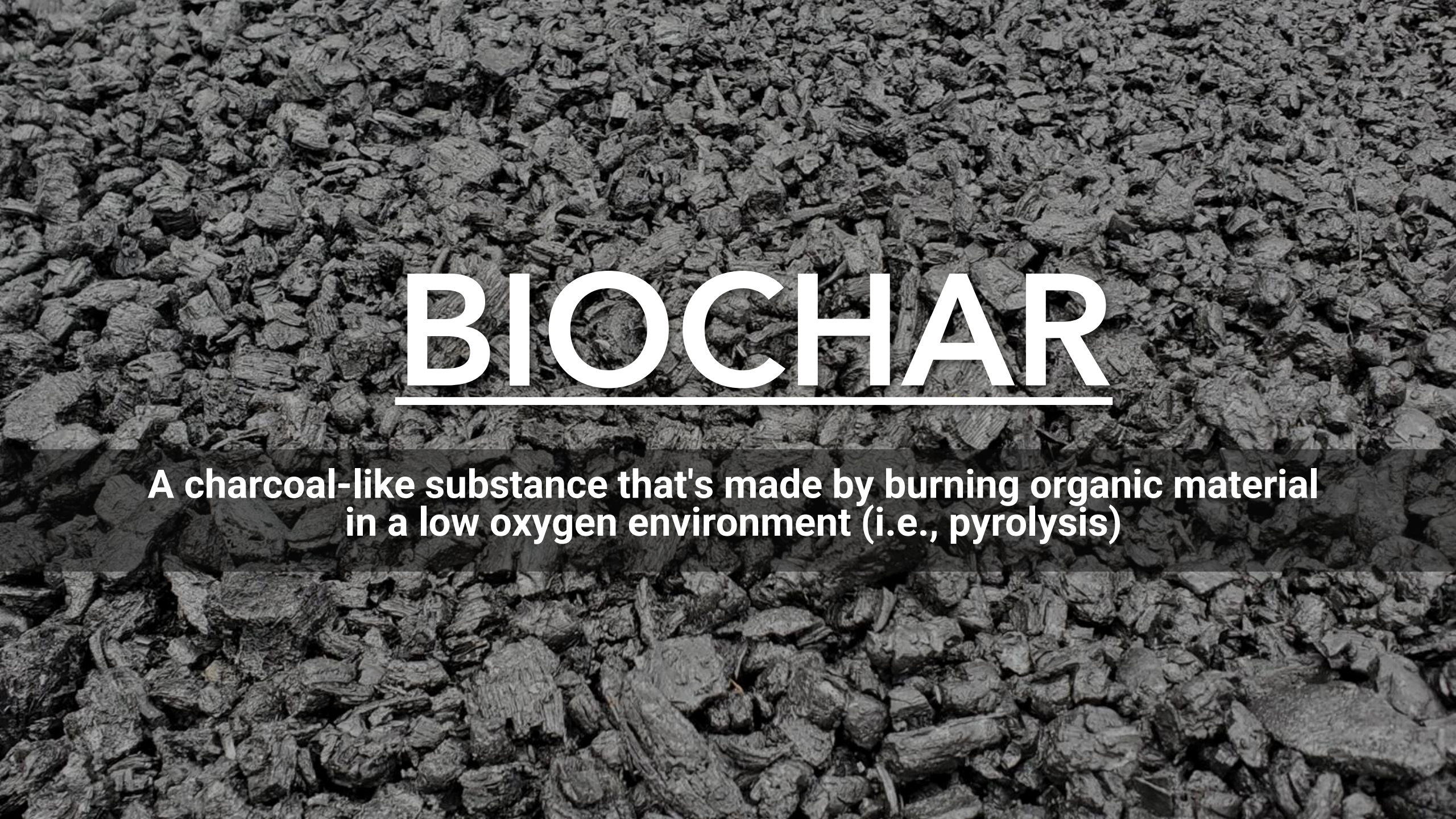
Abandoned Mine Lands (AMLs)

- Poor soil structure
- Sparse vegetation
- Acidic soils
- Heavy metal contamination





BIOCHAR

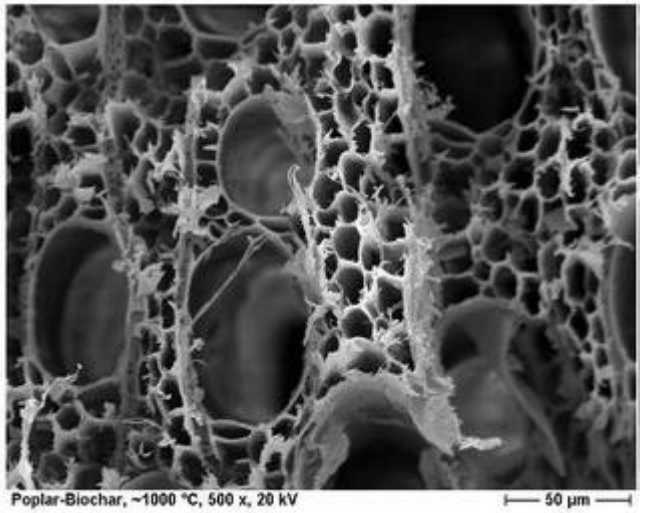
A charcoal-like substance that's made by burning organic material in a low oxygen environment (i.e., pyrolysis)

Biochar Properties

1) Biochar is porous… extremely high surface area, >4000 ha per cubic meter

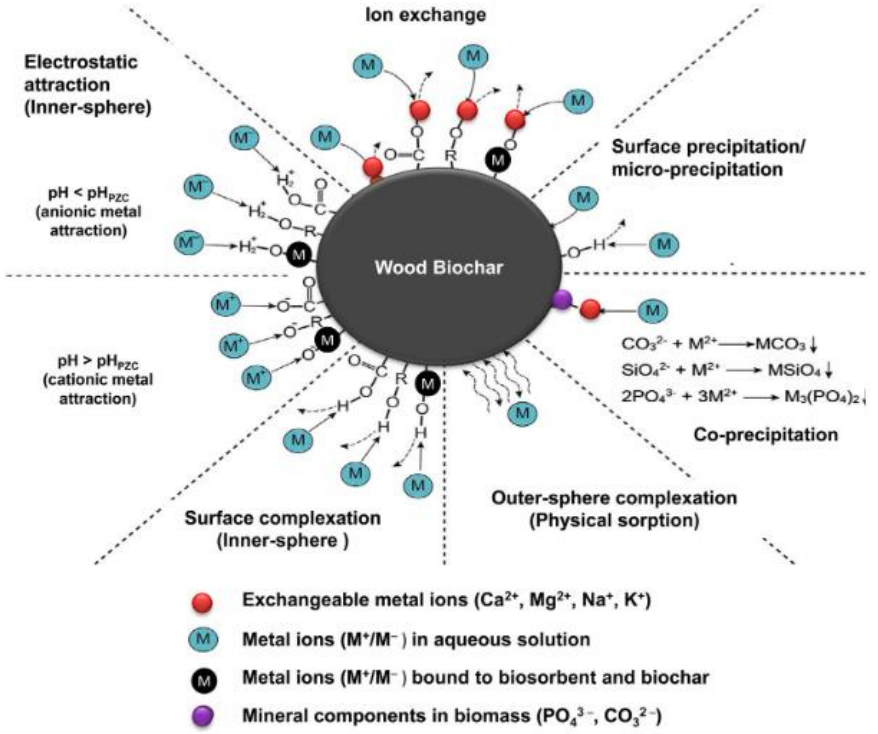
2) Forged in fire → Non-specific binding capacity

3) Adsorption mechanisms:
   - Surface sorption
   - Electrostatic interaction
   - Cation/ion exchange capacity
   - Precipitation
   - Complexation



Microscopic structure of biochar made from poplar wood chips

Biochar-Fungi Interactions in Soils
Katja Wiedner & Bruno Glaser
Biochar and Soil Biota (2013)



Schematic diagram of various sorption mechanisms of heavy metals by biochar in water
(Shaheen et al 2019)

BIOCHAR PRODUCTION

Turning waste biomass into a climate smart product

Photo credit
Nathanael Johnson

Forests “piling up” with low-value wood stock

- From harvest, fuel treatments, rehabilitation & construction projects etc.
- Estimated 368 million dry tons of forest slash can be produced each year in the US (Bufford & Neary, 2010)

Current Practice:
Pile Burning

Slash piles are burned for disposal

Photo Credit: C. Rhoades, L. Asherin; USFS-RMRS

Negatives:

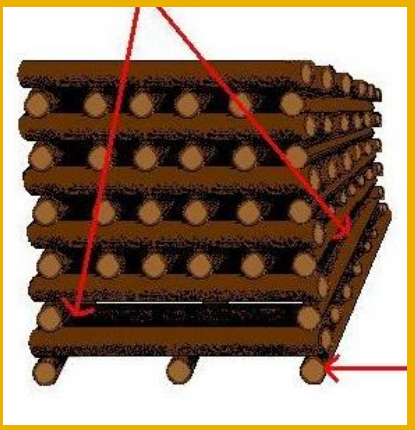
- Air quality impact
- Fire risk
- Loss of soil OM
- Nutrient volatilization
- Legacy of burn scars
- Few trees or shrubs
- Invasive species

Let's Make Biochar

- Intentionally built slash piles
- Kilns in a variety of sizes
- Air curtain burners

Hand-built piles

Protect the ground and restrict airflow



Credit: Jim Archuleta

Ring of Fire Kiln

Box Kiln

Carbonator by TigerCat©

Charboss by AirBurner©

BENEFITS

of using biochar as a soil amendment…

Soil Moisture Retention

Biochar can:

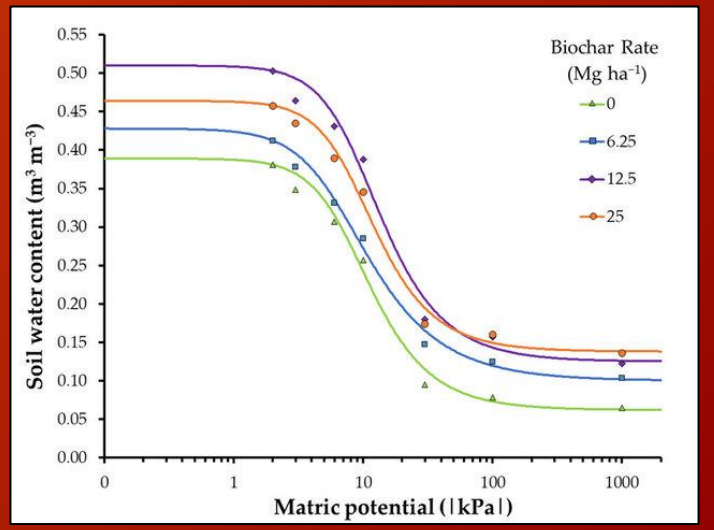
- Decrease overland flow
- Increase infiltration

Biochar increased available water:

- 38%: coarse-textured soil
- 19%: medium-textured soil
- 16%: fine-textured soil

Data from: Blanco-Canqui, 2017; Edeh et al., 2020; Razzaghi et al. 2020

Lustosa Carvalho, Martha, et al. 2020



Heavy metal immobilization

Relative to other methods of heavy metal remediation, biochar application is:

- Economically practical
- Environmentally friendly
- Fast application and effects

Gholizadeh, Mortaza, and Xun Hu. "Removal of heavy metals from soil with biochar composite: A critical review of the mechanism." *Journal of Environmental Chemical Engineering* 9.5 (2021): 105830.

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Journal of Environmental Chemical Engineering

Volume 9, Issue 5, October 2021, 105830

Removal of heavy metals from soil with biochar composite: A critical review of the mechanism

Mortaza Gholizadeh [b], Xun Hu [a]

Show more

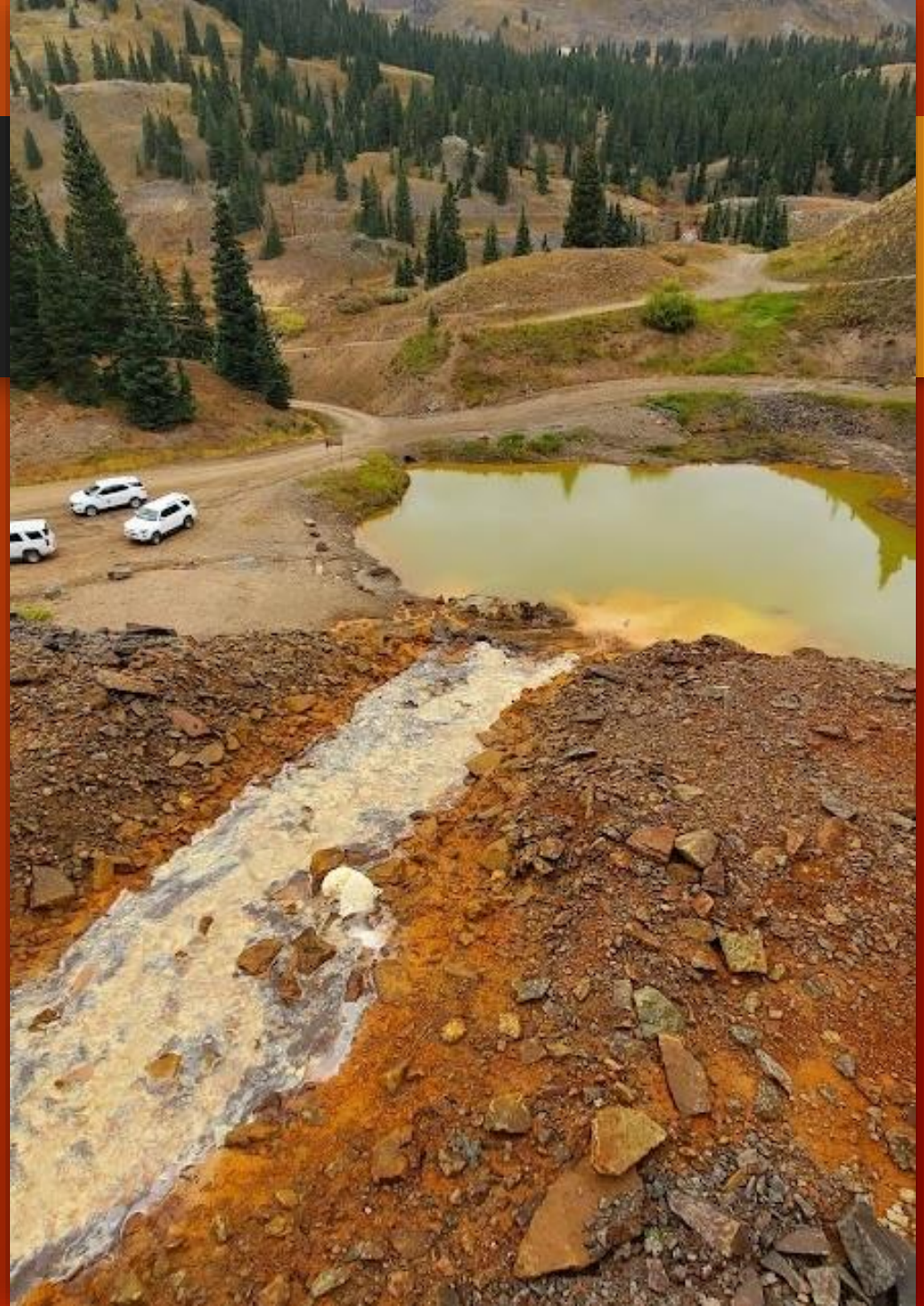
https://doi.org/10.1016/j.jece.2021.105830

Highlights

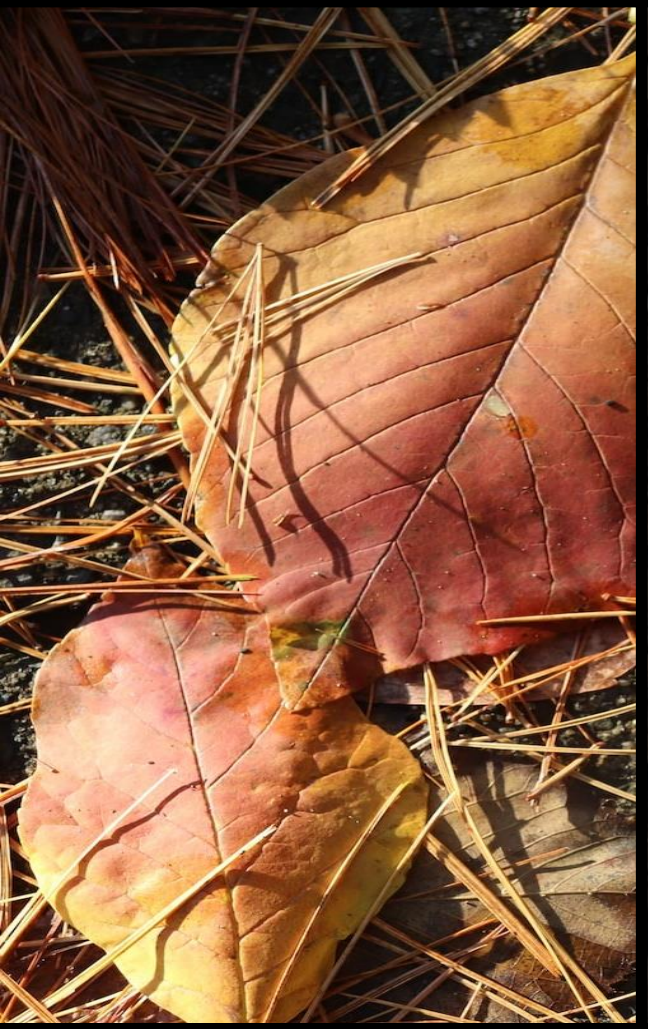
- This study reviewed the different methods for removal of heavy metals from soil.
- Physical method is not economically practical due to high amount of obtained waste.
- Chemical method is expensive and creates new contamination.
- Biological and phytoremediation methods require long time to remove heavy metals.
- Use of biochar composite is the most feasible way to remove heavy metals from soil.

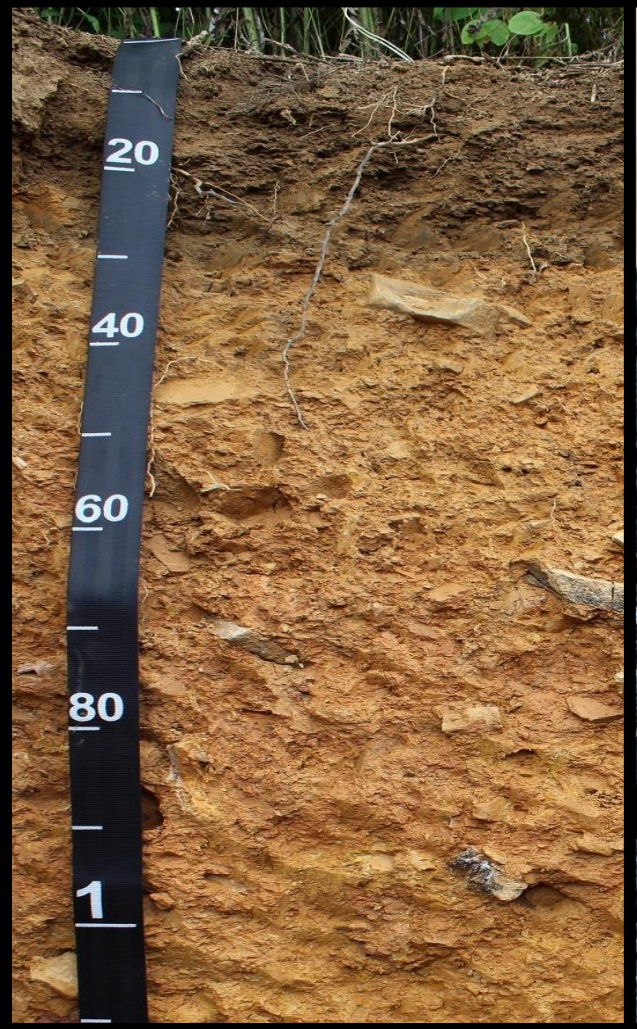
Neutralizing acidity

- Oxidation of sulfide minerals exposed by mining activities increases soil and runoff acidity
- Biochar acid neutralizing capacity is ~3x higher than peat
- Biochar can help establish vegetation, jumpstarting biologic remediation



Carbon Sequestration: Biochar turnover time is relatively slow





~ 1 year | 10-100 yr | 75-200 yr | 300-1000+ yr

^{14}C mean residence times

Skepticism

2000-2015
Black gold rush for biochar research

Generally poor clarification that:

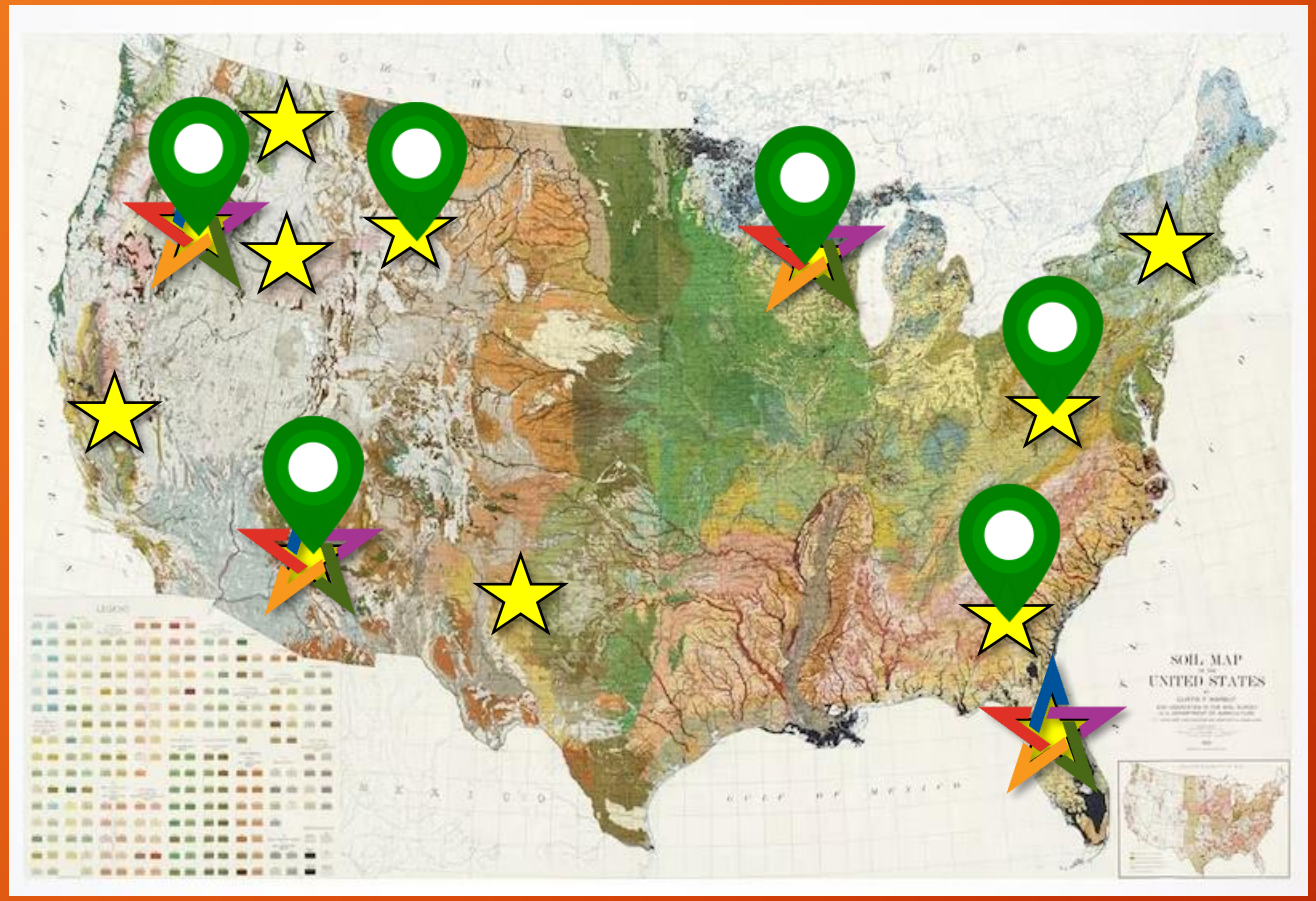
- Biochar types differ
- Site disturbances differ
- Application methods differ

…Field trials…effects vary…

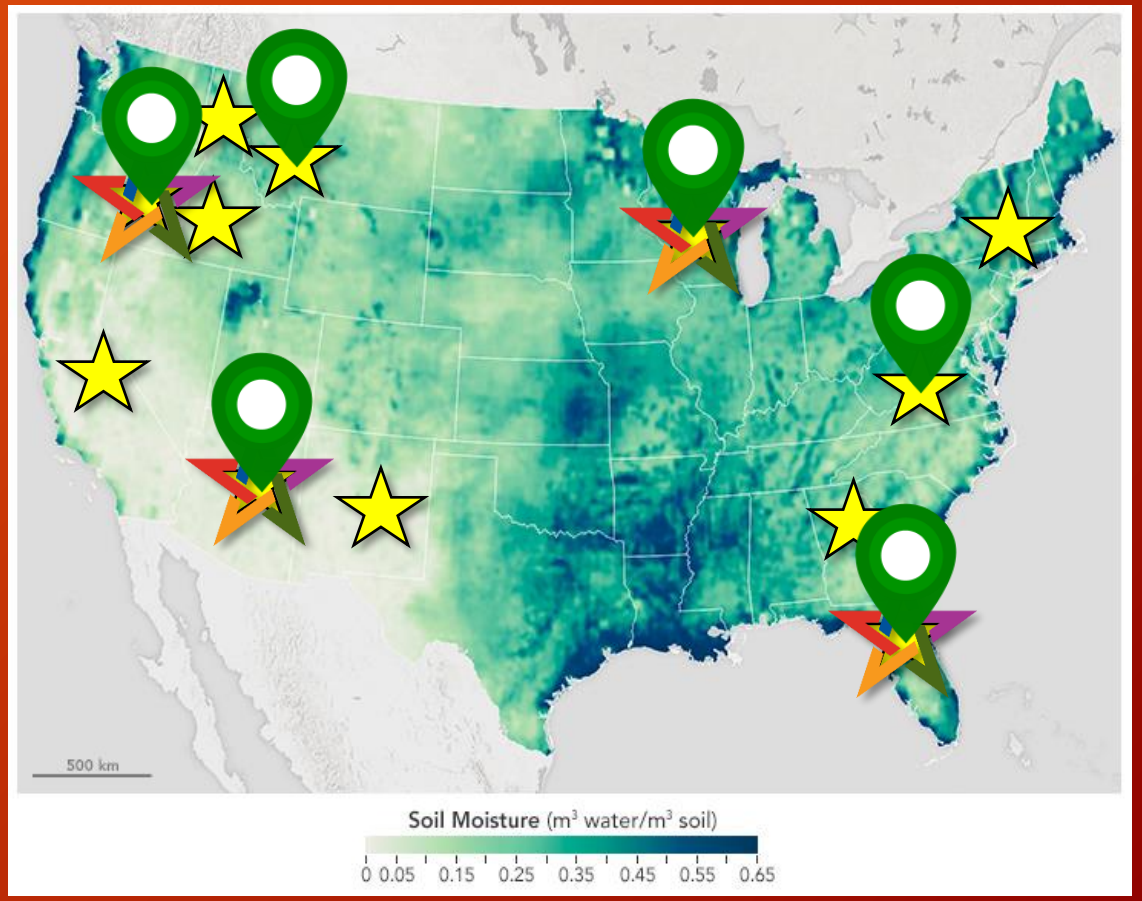
"BIOCHAR DOESN'T WORK"

“What will happen to biochar here?”

Soil Gradient



Climate Gradient



Biochar + Historic placer tailings

- Dredging in historic mining districts confined stream channels and filled in riparian areas with river rock (placer tailings)

➢ <u>Biochar amendment study:</u>

Establish native vegetation

Jumpstart soil development

Low cost and quick to apply

Photo credit: Leo Geis

Low cost, low risk biochar applications

Remediation and seeding of the Missouri Mine CERCLA site in central Idaho.

In collaboration with the Boise National Forest & Boise State University

Thank You

Questions welcome, or via email

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