Science Societies

Keeping lead dust down with clay clumps

Bentonite clay decreases wind erosion at abandoned lead, zinc mine

By DJ McCauley

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The foreground shows what the chat looks like with no amendments—no vegetation, coarse textured, and bare. Photo by Abdulaziz Alghamdi.

- Abandoned mines in the Tri-State Mining District are covered in a substance called “chat” that has elevated levels of lead, cadmium, and zinc.
- Wind erosion moves lead dust from chat to nearby towns while excess zinc prevents plants from growing.
- Kansas State University researchers found that bentonite clay is a good option to reduce wind erosion when revegetation is not manageable.

Lead dust blows in the Kansas wind, away from the remnants of strip-mining operations in the Tri-State Mining District. The wind carries the heavy metal into houses, settling in attics and running through the nearby rivers and streams, creating toxic levels of lead, zinc, and cadmium that impact the health of residents in nearby towns.

If you were thinking of ways to decrease soil erosion, first you might try planting perennials. But what if your soil is too degraded for anything to grow?

A team from Kansas State University found that, without long-term management, it's difficult to get anything to grow on the heavily degraded substance—called “chat”—that's left behind after a strip-mining operation. The group's recently published in *Agrosystems, Geosciences & Environment* study examines soil amendments and revegetation as means of reducing contamination from mining sites near Galena, KS (

https://doi.org/10.1002/agg2.20032).

The Chat

The Tri-State Mining District covers hunks of land in Kansas, Missouri, and Oklahoma. Commercially mined from 1850 to 1970, the heavy metal deposits in the area provided lead for Civil War bullets. Before that, roaming hunters and trappers melted down surface deposits to cast their own ammunition.

But in the aftermath of such heavy mining, a gravelly substance called "chat" covers the surfaces near abandoned mines. Chat is the texture of kitty litter but without its absorbent, scent-reducing properties. It contains virtually no organic matter and elevated levels of zinc—creating growing conditions that are less than ideal for native plants.

Not all of the lead was extracted in the mining operation. Lead dust, along with cadmium and zinc, remain at elevated levels. In 2014, the Kansas State team found 3,400 mg lead kg^{-1} soil sampled at one of its plots. By comparison, your average scoop of soil contains 15 to 40 mg lead kg^{-1} soil (**https://bit.ly/3dc0UmM**).

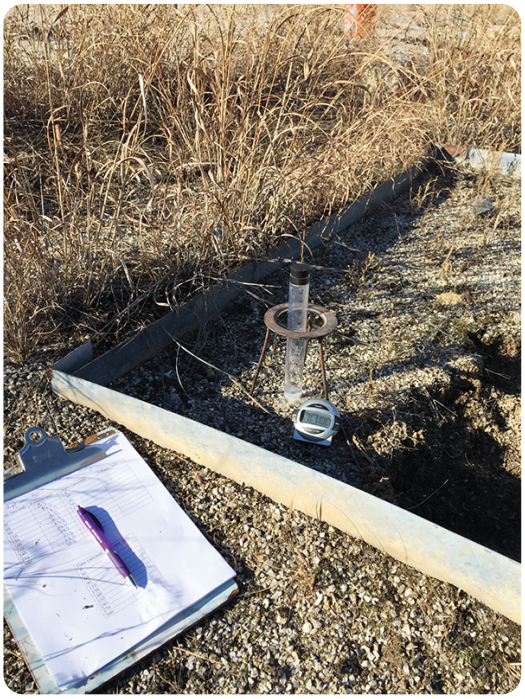
Lead is particularly toxic to children; elevated levels cause developmental delays and learning difficulties (**https://mayocl.in/3fvjDet**). Until recently, chat was not considered hazardous and was just left out on the surface, uncovered.

Several of the mining towns in the district have been declared USEPA "Superfund" sites. As late as 2012, residents in the town of Treece, KS were bought out by the USEPA and evacuated (**https://bit.ly/2CgGP1X**). Decreasing wind and water erosion of heavy metals exposed by chat has public health implications for the towns in the Tri-State Mining District.

The Study

It was this unsolved problem of wind erosion that the Kansas State University team sought to solve. The study was initiated by Gary Pierzynski, now at The Ohio State University, and then passed on to a graduate student, Luke Baker. Eventually, Ganga Hettiarachchi took over the project. Along with DeAnn Presley and her then-advisee Abdulaziz Alghamdi, the team designed a study to see if soil amendments and revegetation could decrease erosion at the site over time.

They amended soil near Galena, KS with various combinations of manure compost, lime, bentonite clay, and switchgrass seeds. The first attempt at revegetation was repeated—the manure compost itself was too saline for growth and the summer was abnormally dry.



Measuring hydraulic conductivity with a mini-disk infiltrometer. Photo by Abdulaziz Alghamdi.

After applying the treatments, the team roto-tilled them into the chat. On the seeded plots, annual ryegrass was grown as a winter cover crop, killed, and then re-seeded with switchgrass. Then the plots sat untested for 8.5 years.

“We waited so long because we wanted to see if the treatments had lasting effects,” Presley explains. “It's not an agricultural system, so we didn't go in and manage the sites. But even after all that time, you *can* see some differences.”

The team found that revegetated plots that did not have bentonite clay amendments did have switchgrass growing in small clumps. But the bigger findings were the changes caused by the addition of clay.

“The bentonite treatments had higher dry aggregate stability,” Presley says. “That means the wind erodible fraction of the soil is lower—the bentonite caused the chat to clump up.”Increasing dry aggregate stability not only traps some lead dust but also decreases the distance particles that do get picked up can travel.

John Tatarko, a USDA-ARS scientist specializing in wind erosion, notes that increasing dry aggregate size and stability increases surface roughness. Rougher surfaces both slow down wind speed and create low spots that trap particles, preventing them from traveling as far if they do get picked up.

“If you can keep wind erosion down in problematic places—like the crest of a hill, for example—you can prevent eroded particles from impacting other particles in less susceptible areas and causing them to move. It's kind of an avalanche effect,” Tatarko says.

The KSU team's findings add support for bentonite as a means of decreasing surface erosion in areas where revegetation isn't a viable option.

The evidence the team compiled on bentonite clay as a long-term means of decreasing erosion could help areas in the Tri-State Mining District that are negatively impacted by windborne heavy metals.“Living with the chat—it's just a part of life here,” Presley says. “But if we can do something that has lasting effects on wind erosion with just a little material and time, well, then it's worth it.”

Dig deeper

View the original article, “Efficacy of Amendments to Improve Soil Physical Properties at an Abandoned Lead and Zinc Mine,” in *Agrosystems, Geosciences & Environment* at **https://doi.org/10.1002/agg2.20032**.

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