Direct phyto-remediation is not suitable for managing and rehabilitating sulfidic and metallic tailings

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Mining and extracting base metals from rock ores have desposited large amounts of sulfidic and metallic tailings and are posing pollution risks worldwide. Scientific communities have published numerous papers regarding conventional methods to remediate directly the tailings and embark on metal-hyperaccumulating plant species, but which unfortunately, have failed to deliver practical solutions to rehabilitate sulfidic tailings for the outcomes of non-polluting and sustainable ecosystems. Sulfidic tailings are polymineral wastes rich in sulfides embedded in fine textured solid phase, far from being “contaminated soil”. Conventional methods using remediation inputs (e.g., organic matter, fertilisers) and practices (e.g., watering, tilling), cause continual oxidation of sulfides along the continuous profile of tailings from the surface to depth, or acidification and associated release of high concentrations of metal(loid)s in the rhizosphere. This renders non-sustainable growth of introduced plants even possessing traits of high metal(loid) tolerance in soil matrix. In addition, high loads of metal(lod)s in tailings particles at exposed surface don’t comply with “non-polluting” criteria, because of the high total levels of metal(loid)s in fine particles suspended in surface runoff and airborne dusts and metal(loid)s in plant food for wildlife, even with full revegetation. Our recent research findings on highly weathered and cemented tailings cap have led to a new ecological engineering method to manage and rehabilitate sulfidic metallic tailings. In this new method, microbial mediated oxidation of sulfides and mineral weathering is proactively accelerated for the *in situ* development of hydrogeochemically inert and densely cemented tailings cap at the surface layer (ca. 50 cm). The cap possesses desired physical integrity and hydraulic resistance, interrupting the hydraulic links between root zones above and unreactive tailings in the depth; thus, preventing metallic drainages, and sustaining diverse native plant species for non-polluting outcomes.