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Long-term effects of vegetation cover on the rehabilitation of lead/zinc mine tailings

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High-volume, fine grain tailings produced from ore processing are commonly disposed in tailings management facilities where leachate production and dust formation are key problems. Establishment of vegetation cover can bring benefits such as physical and chemical stabilisation and increased biodiversity. Vegetation grown directly into waste surfaces minimises the need for imported topsoil or impermeable capping. However, mine tailings are harsh environments for plant growth, lacking organic matter, nutrients, and potentially containing bioavailable toxic elements.

Core materials were taken from three different ages of Pb/Zn mine tailings under management at Boliden Tara, Ireland (Fig. 1). At this site, carbonate-hosted sulphide ores are separated from gangue minerals to form carbonate-rich tailings containing trace amounts of pyrite and potentially toxic elements such as Pb, Zn, Ni and Cu. Vegetation cover was established using organic compost and seeding grasses. Over time, a robust cover of perennial grasses, clovers and (after 8 years) trees became established.

There was an discernible evolution of geochemical parameters over time as pyrite oxidation removed Fe(II), producing Fe(III) hydroxides and gypsum, resulting in a small increase in substrate pH after 8 years (Fig. 2). Organic matter content increases over time, most notably in the 0-5 cm surface layer, but also observed down to ~25 cm after 3 and especially 8 years. DNA extracted from the surface layers also increased in concentration over time as a more diverse microbial community was established. There was a decrease in water soluble metals in 8 year old samples as sulphide-associated metals (e.g. Pb, Zn, Ni) become oxidised and are readily adsorbed by neoformed Fe(III)-oxides. However Cu is more soluble in surface layers irrespective of age, possibly due to an association with water leachable DOC. These data show that a thin soil-like layer can established on Pb/Zn tailings which has only minor (beneficial) effects on metal mobility.

Figure 1. Vegetation cover established on lead/zinc tailings 1, 3 and 8 years after seeding and compost application.

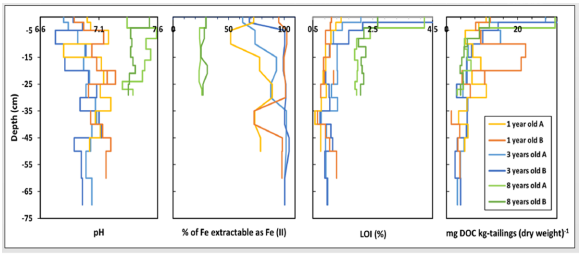

Figure 2. Variation in pH, Fe(II) content, Loss on Ignition (550°C) and water extractable DOC in tailings materials 1, 3 and 8 year old samples.