Towards sustainable mine waste management: Finding value in wastes via the Ferrite process and Geopolymerisation

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ABSTRACT

Sustainable management of mine tailings, waste rocks, and acid mine drainage (AMD) remains one of the biggest environmental challenges of the 21st century. Management of AMD especially from metal sulphide mines, for example, still relies primarily on chemical neutralisation, a process that treats AMD by adding basic materials to increase its pH and remove most of the heavy metals via precipitation. Although this approach and its various modifications are effective, they become unsustainable in the long run because these strategies require the continuous supply of neutralizers, energy, and manpower but do not produce products of economic value. In fact, chemical neutralisation generates toxic and high-volume sludge that has to be disposed of either in special landfills or back to the tailings dams. In this study, we introduce two strategies that would add value to AMD and mine tailings/waste rock: (1) The Ferrite Process, and (2) geopolymerisation. The Ferrite process recovers dissolved iron in AMD and transforms it to magnetic ferrites that can be applied to a wide variety of applications such as sorbents of toxic metalloids like arsenic and selenium and raw materials for paints and magnets. In addition, the Ferrite process could be integrated into existing lime neutralisation plants and the sludge generated has higher solid content and stability. Meanwhile, geopolymerisation is a technique whereby AlO_4 and SiO_4 tetrahedra are linked or "polymerised" together via "activation" using strongly alkaline solutions which, under optimum conditions, could transform wastes rich in aluminosilicates into building and construction materials with excellent compressive strength as well as fire and acid resistances.

Keywords: *Mine tailings; waste rocks; acid mine drainage; Ferrite process, Geopolymerisation*