The role of Portland cement in passive remediation of acid mine drainage (AMD) and control of AMD generation from waste rocks

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Leaching columns tested the effectiveness of cement applications in controlling acid mine drainage generation from pyrite-bearing waste rocks from Brukunga mine, South Australia. Leachates collected from the columns over ~1 year after cement application showed that acidity, metal and sulfate loads decreased greatly (by > 75%). This was due to direct neutralisation of acidity by dissolution of portlandite and hydrated calcium silicate/aluminate phases in the cement, as well as encapsulation of pyrite-bearing rock fragments by cement (reducing oxygen consumption by up to 70%). Low viscosity cement slurries (higher water/cement ratios) covered the waste rocks more extensively, increasing leachate/cement contact time and decreasing sulphide oxidation more than in the columns with relatively viscous cement slurries. Cracks in the cement plug in the upper part of columns with viscous cement allowed leachate to drain quickly, carrying relatively small loads of acidity and metals from uncemented waste rock. The cement plug dissolved very slowly, ensuring continued effectiveness of the cement application for many years.

Cement slurries incorporating fly ash and AMD sludge had similar effects to unblended cements, and the AMD sludge did not release its adsorbed heavy metals, indicating the viability of using these wastes as cement additives to reduce the cost.

Although the neutralising efficiency of the cements decreased as Fe hydroxides and gypsum accumulated on the cement surfaces, the precipitation of ettringite and thaumasite within the cement caused expansion and cracking, allowing deep penetration and therefore relatively efficient neutralisation of AMD. The cracking was enhanced when the cement samples were allowed to dry out, indicating that cement used for passive treatment of AMD will provide better long-term neutralisation in partially unsaturated conditions where the cement dries out periodically, facilitating cracking.

Thus cement is a viable method for controlling acid mine drainage generation from waste rock dumps, and could be applied with both lower and higher water/cement ratios to achieve both deep penetration and surficial retention. Scaling up the results from the laboratory study to the field scale at the Brukunga mine site suggests that benefit/cost ratios in the order of 20–30 might be achieved compared to the present use of lime neutralization for AMD treatment.