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The Formation of Hardpans within Tailings as Possible Inhibitors of Acid Mine Drainage, Contaminant Release and Dusting

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Abstract

The effectiveness of hardpans in the inhibition of acid drainage generation is dependent on reducing oxygen diffusion and water infiltration into the underlying tailings, while maintaining long term stability. A reduction in water infiltration can also diminish the transport of contaminants developed during sulfide oxidation and subsequent reactions. Hardpans developing in base metal, tin and gold mine tailings in Australia have been investigated to determine the factors controlling their formation, mineralogical and geochemical characteristics and their ability to inhibit acid drainage. Three basic types of hardpans have been identified and examined: laterally extensive surface hardpans, laterally extensive cemented layers and laterally discontinuous hardpans developing in locations of seepage. Their mineralogy, morphology, lateral extent, depth and rate of formation is dictated by sulfide and gangue mineralogy and content, milling and depositional techniques of the tailings and the climate.

Water and gas movement through the hardpans at the CSA (Cu, Zn, Pb) and the Elura (Pb, Zn, Ag) mines has been investigated. Permeability tests indicate the hardpans can reduce infiltration rates by 10 to 100 times that of the fresh tailings. Oxygen diffusion rates were calculated and were shown to be up to 1000 times lower in hardpans than in fresh tailings. Such decreases are explained by persistent elevated 'degrees of saturation' within the hardpans. These conditions were verified using a conceptual model of sulfide oxidation reactions, which allowed comparisons of diffusion coefficients with modelled and observed depths of oxidation within the tailings impoundments.

Concerns regarding the long-term integrity and sealing capacity of the hardpans have been expressed by Canadian researchers. Present field observations indicated that the natural hardpans formed by cementing with secondary minerals from sulfide oxidation are very dynamic due to their susceptibility to chemical and physical erosion. Laboratory tests using a wide range of additives have been undertaken to develop hardpans more akin to naturally occurring duricrusts. Some additives have developed cements which have the low permeability and porosity characteristics required, while maintaining a high level of resistance to both chemical and physical break down.