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Metal retention, mineralogy, and design considerations of a mature permeable reactive barrier (PRB) for acidic mine water drainage in Northumberland, U.K.

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Abstract

Mineralogical characterization of the precipitates developed in passive systems treating mine-polluted waters is an essential tool to fully understand and control the removal processes taking place in these systems. In 2008, after five years of operation, a section of the permeable reactive barrier (PRB) at Shilbottle, Northumberland, was subjected to a low intrusive/non-destructive solid sampling. These solid samples were mineralogically characterized by XRD, ESEM-EDS, and sequential extractions. In addition to the solid sampling, 44 water samples obtained in the PRB from January 2004 to August 2009 were used to study the mineral stability of some selected phases in these waters. It was observed that the main iron phases in the PRB were those associated with mineral phases typically developed in non-reducing environments (schwertmannite and goethite), while the presence of a significant amount of pyrite was also observed. The low residence time of the water within the PRB (from 10 to 40 h) appears to be the reason for the absence of a more reducing and less acidic environment in the reactive substrate. An increase of residence time in the PRB, by increasing reactive mixture porosity and resizing the PRB, changes in the reactive material employed (smaller limestone grain size and inclusion of zerovalent iron) and changes in the PRB design (isolating top layer and forced homogeneous flow upward through all the reactive material) are proposed for future reconditioning of the system.

Keywords: Permeable reactive barrier, acid mine drainage, water treatment, metal removal