Permeable Reactive Barriers for Treatment of a Groundwater at a Uranium Mine: Laboratory Evaluation of Reactive Materials.

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Oxidation of sulfide minerals has resulted in the release of low quality water from the Claude waste rock storage area at the Cluff Lake Mine in northern Saskatchewan. This low-quality drainage water has been displaced into an underlying aquifer, resulting in the development of a groundwater plume. The principal element of concern in the plume water is dissolved nickel, which occurs in the range of 2 to 14 mg/L. The plume water has low pH (~4.3), is oxidized, contains high concentrations of dissolved sulfate (1000-4750 mg/L), aluminum (up to 45 mg/L), zinc (up to 3 mg/L), cobalt (up to 3 mg/L) and relatively low concentrations of other dissolved heavy metals and iron. A pilot-scale permeable reactive barrier was installed at the site in 2005, to assess the potential for this technology to control the migration. Laboratory experiments are being conducted in conjunction with the field evaluation to assess the treatment performance of three reactive mixtures, which contained organic carbon and varying amounts of zero valent iron (ZVI).

The reactive materials are combined with gravel to maintain adequate permeability. The organic carbon used in the mixtures was obtained from a peat bog near the waste rock storage area. The mixtures include 1) organic carbon mixed with lime and limestone to buffer the pH; 2) organic carbon mixed with 10 vol. % ZVI and 3) organic carbon mixed with 20 vol. % ZVI. The initial results of the column experiments show that all of the mixtures promote bacterially mediated sulfate reduction and removal of dissolved metals through the formation of secondary metal sulfides. After six months of testing, there was no discernable difference between the two reactive mixtures containing ZVI, and testing of the 20 vol. % mixture was discontinued. Profile sampling indicates that the reactivity of mixture 1, which does not contain ZVI, has declined whereas the reactivity of mixture 2, containing ZVI, has remained constant. The preliminary results of the experiment indicate that the addition of modest amounts of ZVI can increase the longevity of the reactive material. This benefit needs to be weighed against the additional costs associated with the incorporation of ZVI in the reactive mixture.