Concentration-discharge behavior of contaminants in a stream impacted by acid mine drainage

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Acid mine drainage (AMD) has severely degraded many streams world-wide. AMD occurs when pyrite contained in coal is exposed to water and air during mining activities and oxidized to release high concentrations of sulfate, metals, and acid into water bodies. Controls on concentration-discharge (CQ) relationships of solutes in AMD-impacted streams remain unclear due to the complicated nature of acid mine drainage systems. For example, streams may receive inputs from multiple sources including runoff, outflow from constructed treatment systems, and abandoned mines that bypass these systems to continue to contaminate the streams. It is important to understand the CQ relationships of contaminants in AMD-impacted streams in order to elucidate contaminant sources and to predict effects on aquatic ecosystems.

Here, we study the CQ behaviours of acid, metals, and sulfate in a contaminated watershed in northeastern Ohio where a treatment system has been installed to remediate water draining from a mine pool into the stream. The treatment system includes a series of limestone channels and settling ponds designed to increase drainage pH and promote precipitation of Fe- and Mn-oxides. Stream chemistry was measured in samples collected approximately once per day from March through November and hourly during select storm events. Stream flow was measured continuously at the watershed outlet. Contaminant concentrations in the stream generally decreased with increasing stream discharge due to inputs from the treatment system that only occurred at high flow. A decrease in pH from March (~6) through November (~3) was concurrent with a decrease in stream discharge. Correspondingly, AMD-derived contaminants (Fe, Mn, Al) increased in concentration from March through November. These trends reflect mixing of contaminated baseflow and intermittent inputs from the treatment system, indicating that the treatment system is only effective at neutralizing stream acidity and removing metals when flow is present. We determine that constructed treatment systems can act as ephemeral tributaries to the stream and control CQ behaviour at the stream outlet.