Water Quality of the upper Animas River, before, during, and after the Gold King Mine Release

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The August 2015 Gold King Mine release sent 3 million gallons of acidic, metal-rich water flowing down Cement Creek and the Animas River in southern Colorado, creating an orange plume of contamination that extended into the San Juan River in northern New Mexico. This unfortunate incident has refocused attention on the Silverton Colorado area, where mining activities dating back to the 1800s have adversely affected water quality in the upper Animas River, Cement Creek, and Mineral Creek. This presentation describes instream water quality in the Silverton area before, during, and after the Gold King Mine Release, with emphasis on the predominant sources of contamination, as well as the fate and transport processes that affect metals as they move downstream.

Water quality prior to the release is described using data from an October 2012 synoptic study that provides spatially detailed profiles of streamflow, concentration, and metal load. Results of the 2012 study indicate that concentrations of aluminum, cadmium, and zinc exceeded chronic aquatic life standards over the entire length of the study reach (Cement Creek headwaters to Bakers Bridge on the Animas R. upstream from Durango) (Figure 1A). Spatial profiles of metal load indicate specific source areas for various metals. The Red and Bonita Mine on Cement Creek, for example, accounts for nearly 20% of the zinc loading within the study reach. Further, the North Fork of Cement Creek, which includes drainage from the Gold King Mine, accounts for 40% of the copper load, and Mineral Creek accounts for over 40% of the aluminum load (Figure 1B).

Water-quality samples collected at the mouth of Cement Creek during the second week of the release document increases in aluminum, copper, and other metal loads when compared to historical data from 2009-2014 collected under similar low-flow conditions (Figure 2). Metals transported from the Silverton area are subject to pH-dependent reactions (precipitation and sorption) that transform metals from the dissolved phase to colloidal particles as pH increases. These colloids aggregate and settle to the streambed, which can lead to elevated metal concentrations in the sediment. Bed sediment samples collected at USGS gage 09359020 (Animas River below Silverton, CO) after the release suggest increased concentrations of arsenic, chromium, copper, and vanadium when compared to data collected prior to the release (September 2014) (Figure 3A). Sediment concentrations of cadmium, iron, manganese, nickel, titanium, and zinc were lower following the release (Figure 3B), whereas silver, aluminum, and lead concentrations were relatively unchanged. These results suggest that the effects of the release on overall sediment quality may be minimal, relative to historic conditions. The quantity of contaminated sediments has likely increased, however, and additional monitoring may be needed to assess the effects on aquatic life, irrigation and water-supply infrastructure, and recreational resources.

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Figure 1A

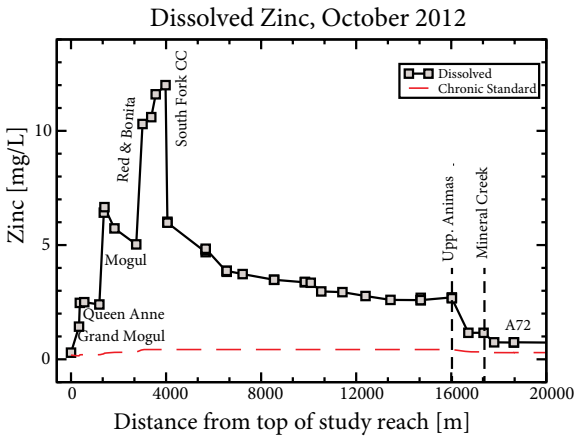

Figure 1B

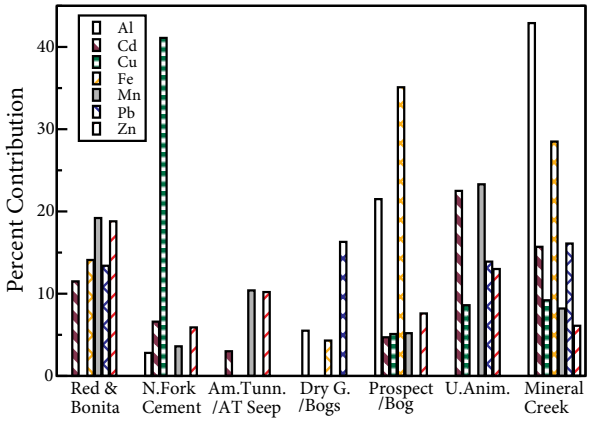

Figure 2A

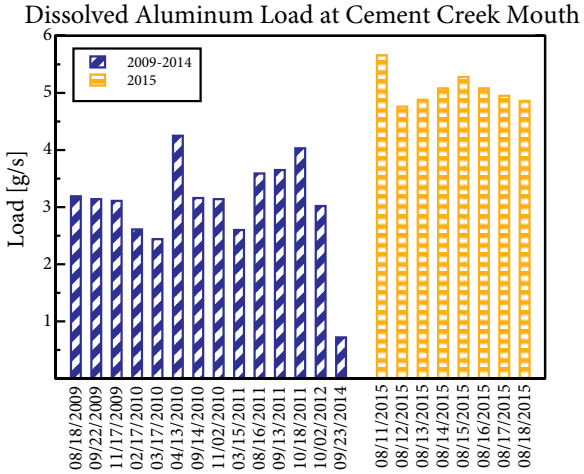

Figure 2B

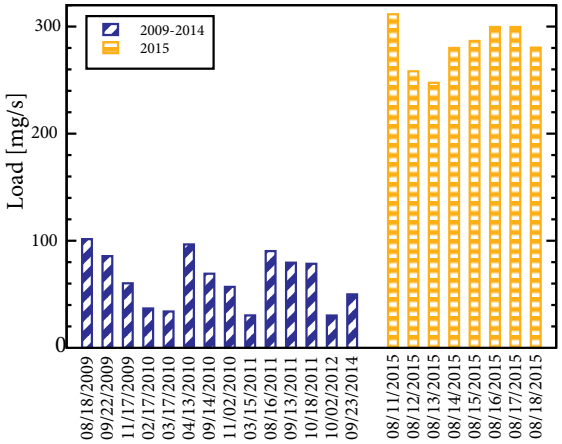

Figure 3A

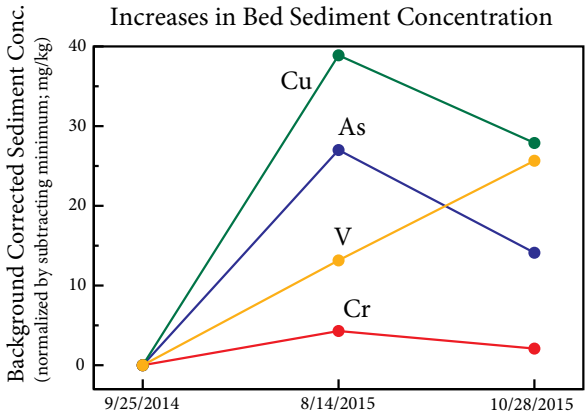

Figure 3B