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CHEMICAL AND HYDROLOGIC DATA FROM THE CEMENT CREEK AND UPPER ANIMAS RIVER CONFLUENCE AND MIXING ZONE, SILVERTON, COLORADO, SEPTEMBER 1997

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Conversion Factors

Multiply	By	To obtain
meter (m)	3.281	foot (ft)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

Chemical and hydrologic data from the Cement Creek and upper Animas River confluence and mixing zone, Silverton, Colorado, September 1997

Marisa H. Cox, and Laurence E. Schemel

Abstract

Cement Creek, an acidic tributary, discharges into the circum-neutral Animas River (pH>7) in Silverton, Colorado located in the high-elevation San Juan Mountains. Mixing of Animas River water with acidic metal rich Cement Creek water raises downstream pH and produces metal precipitates. This report presents selected anion, cation, chloride, and sulfate data along with hydrologic data highlighting the mixing of these streams during the low-flow period in late summer 1997.

Introduction

The highly mineralized Silverton caldera located in the high-elevation San Juan Mountains of southwestern Colorado, was intensely mined for over a century primarily for gold, silver, zinc and lead (Baars, 1992; Yager and Bove, 2002). The abandoned mines and natural mineral deposits continue to supply dissolved and colloidal metals to the upper Animas River and Cement Creek, as well as other streams in the caldera (Church and others, 1997). The acidic Cement Creek (typically pH<4) flows into the circum-neutral Animas River (pH>7) near the town of Silverton, creating a mixing zone where products of chemical reactions are clearly evident in the water and on the streambed (Schemel and Cox, 2005). The higher pH of the downstream mixture forms iron and aluminum colloidal-size particles that can strongly influence water chemistry (Schemel and others, 2000; Schemel and others, 2006).

The September 1997 study area includes the upper Animas River and Cement Creek downstream from the USGS discharge gauges, the main river channel where the two streams progressively mixed, and the downstream reach, where the river was well mixed upstream from the confluence with Mineral Creek (Figure 1). Site numbers used here refer to the distance downstream from a tracer injection point, which was 145 m below the Cement Creek gage (Schemel and others, 2006). The term mixing zone refers to all main-channel sites downstream from the confluence of Cement Creek and Animas River. The purpose of the report is to present the chemical and hydrologic data of the upper Animas River mixing zone during the September 1997 field campaign. Additional information about the sampling strategy and across-channel field measurements are discussed in Schemel and others (2006).

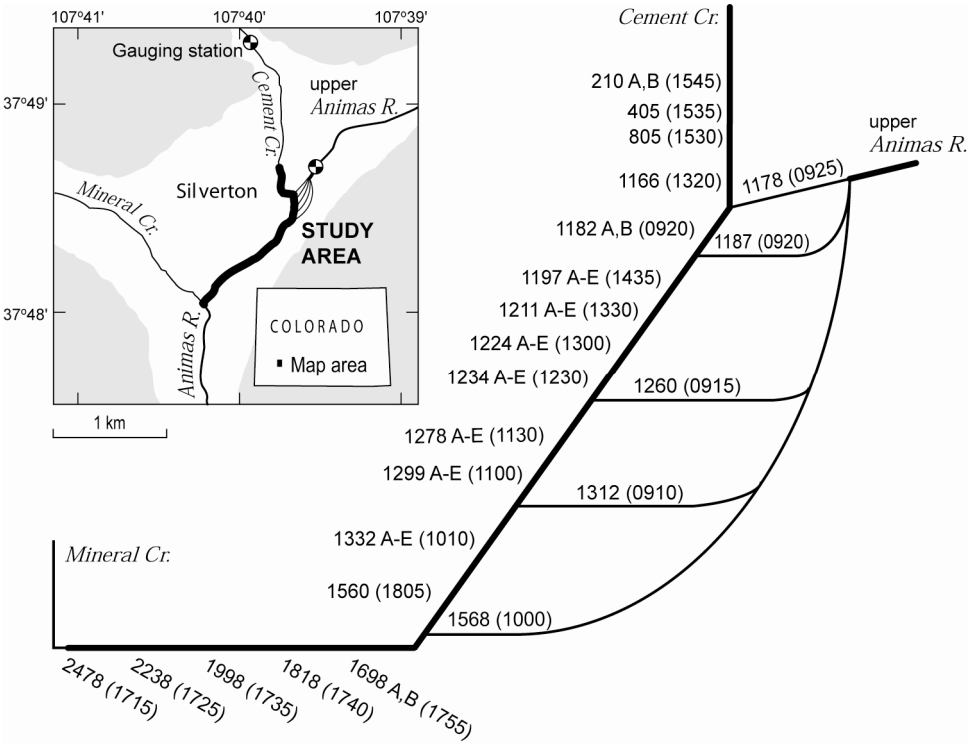

Figure 1. Map showing Cement Creek and upper Animas River confluence and mixing zone near Silverton, Colorado. Sites where multiple stations were sampled across the channel are shown by A, B (two stations), and A-E (five stations). Sampling times are shown in parentheses.

Acknowledgements

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Methods

Sample collection and processing

Water samples were collected at sites in Cement Creek, upper Animas River and within the mixing zone (Figure 1). A sample was collected midstream in each of the five Animas River braids (sites 1178, 1187, 1260, 1312, 1568). Each of the seven mixing zone transects (1197, 1211, 1224, 1234, 1278, 1299, 1332) contains five sampling stations for better characterization of the large across-channel gradients. Specific conductance and discharges were measured at intervals of 0.3 to 0.6 m across the transect to characterize the channel gradients and determine sampling station locations. Incremental discharge was estimated using current velocity and depth measured across the stream at each site. Specific information on the sampling approach is reported in Schemel and others (2006).

Water samples were collected over a 9 hour period and processed the same day. These samples were collected using a vertically integrating sampler fit with plastic bottles and nozzles that were pre-cleaned with dilute nitric acid and rinsed with sample water at each station. After shaking briefly, whole samples (RA) were decanted for metal analyses, and specific conductance and pH were measured with portable meters in the field. The remainder of each sample was filtered with a tangential-flow filtration apparatus for using 0.45 μm polycarbonate membranes (FA filtrates) and 10k Dalton (approx. 0.001 μm pore size) regenerated cellulose membranes (UFA filtrates). The filtration apparatus was cleaned with dilute nitric acid and rinsed with 18.2 M deionized water between samples. All samples for metal analyses were acidified with ultrapure nitric acid (1 % final acid concentration). Whole samples were filtered through 0.45μm capsule filters after digestion in 1 % nitric acid for one month or more.

Analytical methods

Water samples were analyzed for metals with a Thermo Jarrel Ash inductively coupled plasma-optical emission spectrometer (ICP-OES; any use of trade, product, or firm names is for descriptive purposes only and does not constitute endorsement by the US Government). Samples for metals were diluted with 1 % ultrapure nitric acid (based on their specific conductance values) prior to analysis. The filtrates were analyzed sequentially to minimize effects of analytical errors on colloid concentrations, which were estimated by difference.

Anion samples were analyzed for Cl^- and SO_4^{2-} with a Dionex ion chromatograph as outlined in Kimball and others (1999). Dissolved Fe speciation (Fe^{2+}, Fe^{3+}) was measured on FA filtrates using the colorimetric bipyridine method, as described by Skougstad and others (1979). Reagents were added to the filtrates at the field laboratory and absorbances were measured on a spectrophotometer within one to two days.

Mixing Ratio Calculation

The mixing ratios (the volumetric fraction of each component in the mixture) provide fundamental information for samples collected in the downstream mixing zone. Mixing ratios were calculated in terms of percent upper Animas River water, based on concentrations of metals and anions from each sample in the mixing zone:

$$\%AR = \frac{[CC] - [MZ]}{[CC] - [AR]} x100$$

where [CC], [AR], and [MZ] are concentrations in Cement Creek, Animas River, and mixing zone, respectively.

End member concentrations for the Animas River were mean values from samples collected in the braids. Mass flows were calculated from chemical data and measured or estimated discharges for selected sites. More detailed information about sample collection, processing, mixing ratio calculations and analytical methods are reported in Schemel and others (2006).

Field Data

The chemical and hydrologic data are located in the attached date file. The Excel data file contains three spreadsheets containing data on: Discharge, Chemistry, and Hydrology.

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