Geochemical Data from Waters in Prospect Gulch, San Juan County, Colorado, that Span Pre- and Post-Lark Mine Remediation

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U.S. Department of the Interior
U.S. Geological Survey

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By Raymond H. Johnson, Douglas B. Yager, and Hugh D. Johnson

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
yard (yd)	0.9144	meter (m)
	Volume	
ounce, fluid (fl. oz)	0.02957	liter (L)
pint (pt)	0.4732	liter (L)
quart (qt)	0.9464	liter (L)
gallon (gal)	3.785	liter (L)
gallon (gal)	0.003785	cubic meter (m^3)
cubic inch (in^3)	0.01639	liter (L)
cubic foot (ft^3)	0.02832	cubic meter (m^3)
cubic yard (yd^3)	0.7646	cubic meter (m^3)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
	Mass	
ounce, avoirdupois (oz)	28.35	gram (g)
pound, avoirdupois (lb)	0.4536	kilogram (kg)

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:
°C=(°F-32)/1.8

SI to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
meter (m)	1.094	yard (yd)
	Volume	
liter (L)	33.82	ounce, fluid (fl. oz)
liter (L)	2.113	pint (pt)
liter (L)	1.057	quart (qt)
liter (L)	0.2642	gallon (gal)
cubic meter (m^3)	264.2	gallon (gal)
liter (L)	61.02	cubic inch (in^3)
cubic meter (m^3)	35.31	cubic foot (ft^3)
cubic meter (m^3)	1.308	cubic yard (yd^3)
	Flow rate	
cubic meter per second (m^3/s)	35.31	cubic foot per second (ft^3/s)
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.205	pound avoirdupois (lb)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:
°F=(1.8×°C)+32

Abbreviations

mg/L = milligrams per liter
μg/L = micrograms per liter
cfs = cubic feet per second
km = kilometer
cm = centimeter
μm = micron

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Abstract

In San Juan County, Colorado, the effects of historical mining continue to contribute dissolved metals to groundwater and surface water. Water samples in Prospect Gulch near Silverton, Colorado, were collected at selected locations that span pre- and post-reclamation activities at the Lark Mine, located in the Prospect Gulch watershed. Geochemical results from those water samples are presented in this report. Water samples were analyzed for specific conductance, pH, temperature, and dissolved oxygen with handheld field meters, and metals were analyzed using inductively coupled plasma–mass spectrometry.

Introduction

In the late nineteenth century, San Juan County, Colo., was the center of a metal mining boom in the San Juan Mountains. Although most mining activity ceased by the 1990s, the effects of historical mining continue to contribute dissolved metals to groundwater and surface water. Streams in this area have low pH and elevated metal loads due to naturally occurring acid-rock drainage, but the influence of acid-mine drainage due to historical mining activities has further degraded preexisting groundwater and surface-water quality (Church and others, 2006).

In order to better understand the impact of historical mining on groundwater and surface-water quality in Prospect Gulch, additional research in the area was initiated by the U.S. Geological Survey (USGS) in 2004. Resulting data were previously summarized and provided in Johnson and others (2007). The data provided by Johnson and others (2007) give analytical results for waters in Prospect Gulch through June 2006. Specific locations in Prospect Gulch were identified for continued sampling (fig. 1), and new data from those locations are provided in this report for the period of June 2008 through June 2010 (tables 1 and 2). During this time period, waste rock at the Lark Mine (fig. 1) was excavated and encapsulated in a plastic liner by the Bureau of Land Management. This work was done during the fall of 2006 and spring of 2007. The data provided in this report include analyses for stream samples in Prospect Gulch that spans the pre- and post-Lark Mine remediation efforts. In addition, data from a monitoring well (MPG-D-13, fig. 1), which was placed within the groundwater-contaminant plume down-gradient from the Lark Mine waste-rock dump, are also included as these data also span pre- and post-remediation efforts (table 1). As part of the encapsulation of the Lark Mine waste rock, a drain was placed underneath. Analysis data for samples taken from this drain on four occasions are also provided (table 1).

Hydrologic Setting

The stream in Prospect Gulch is approximately 2.4 km in length with an elevation change of 800 m from headwaters to mouth. Average annual precipitation is about 114 cm with 94 cm occurring as snowfall, as confirmed by measurements at Gladstone, Colo. (3.2 km north of Prospect Gulch), by Sunnyside Gold Corporation (Wirt and others, 2001). As a result, the majority of water available for recharge into the groundwater system occurs in late May and early June during the spring snowmelt. Late June through September is dominated by summer thunderstorms producing rainfall that provides additional water for groundwater recharge (Wirt and others, 1999). Snow generally covers the ground surface in most of Prospect Gulch from October through early May, with the frozen conditions preventing any significant recharge to the groundwater system during that time span.

Methods

Water samples were collected either through tubing connected to a peristaltic pump or with a plastic syringe. All samples were field filtered. Field parameters included pH, specific conductance, temperature, and dissolved oxygen measured via standard handheld field meters. The peristaltic pump samples used an in-line 0.45-micron (µm) capsule filter, and syringe samples used a syringe-mounted 0.45-µm disc filter.

Water samples were analyzed by inductively coupled plasma–mass spectrometry (ICP–MS), and upon collection were acidified to a pH <2 with ultra-pure nitric acid. Analyses for major and minor cations, trace elements, and sulfate were completed at the USGS Mineral Resources Laboratory in Denver, Colo., using the ICP–MS methodology described by Lamothe and others (2002).

Data

All of the resulting data are provided in table 1, with sample names indicated in bold to match figure 1. For some sampling events, the sample names were different, and these sample names have been preserved in tables 1 and 2 to match the original data. Some of these data were initially reported in Johnson and others (2007), but are repeated here for ease of use in pre- and post-reclamation comparisons. Note that the samples taken on October 4, 2004, were collected during a lithium bromide tracer test. As a result, the lithium concentrations (and interference with arsenic and selenium) are artificially high and not naturally occurring. Also for ease of use, table 2 presents the same data as table 1, but the data are organized as a downstream series collated by sample date. Since stream discharge is important in evaluating the geochemical conditions (mainly stream load and dilution), the stream discharge data from the nearest gage at the mouth of Cement Creek in Silverton, Colo. (USGS gage #09358550), are included in table 3 (provided only for dates when samples were collected). Manually measured stream discharge data for the mouth of Prospect Gulch were collected for several months in 2004 and 2005 and are provided in Johnson and others (2007).

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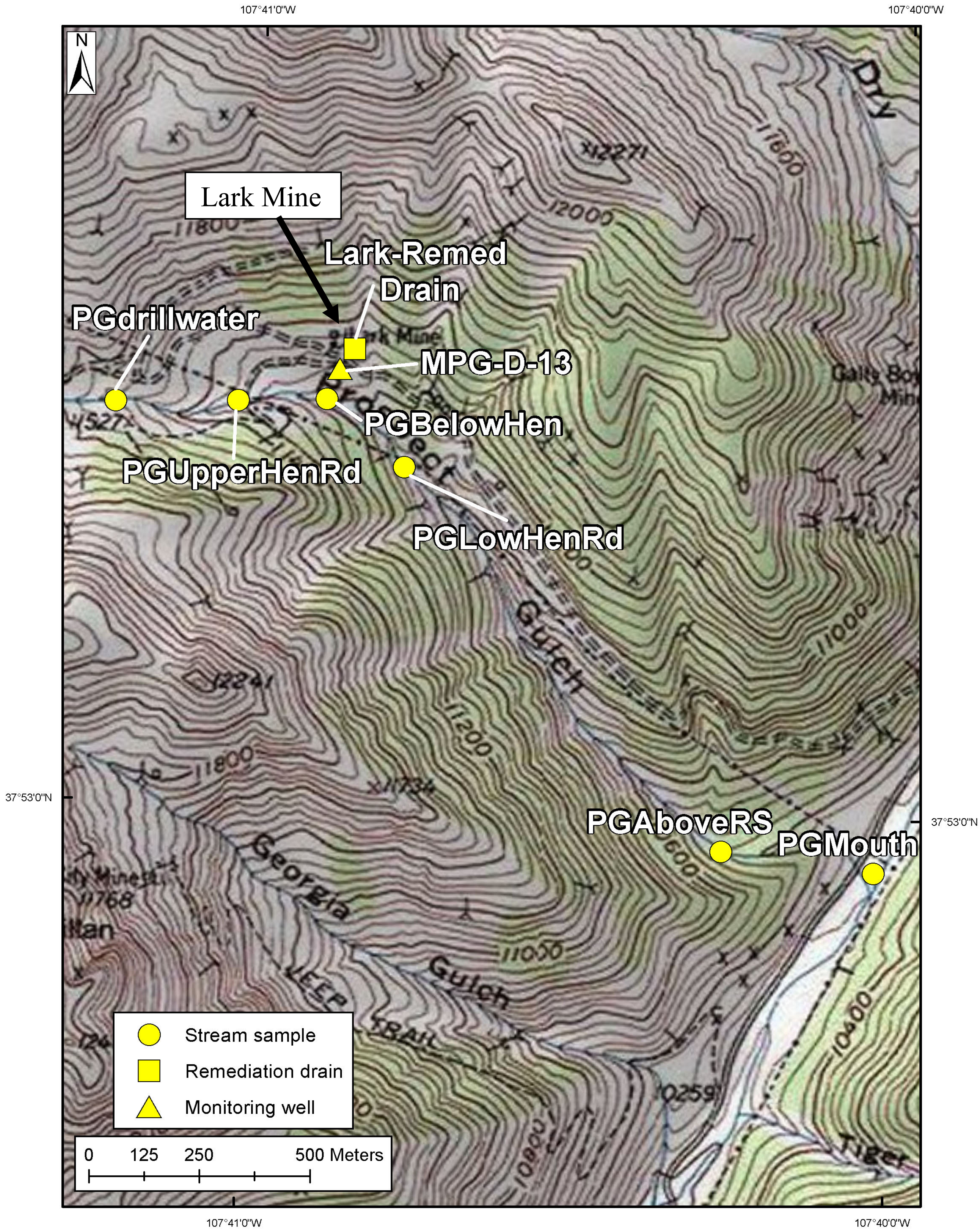

Figure 1. Sample locations in Prospect Gulch.