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Geochemical Results of Lysimeter Sampling at the Manning Canyon Repository in the Mercur Mining District, Utah

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Conversion Factors and Abbreviations

Inch/Pound to SI Units

Multiply	By	To obtain
centibar (cbar)	1.0	kilopascal (kPa)
foot (ft)	0.3048	meter (m)
inch (in)	25.4	millimeter (mm)

SI Units to Inch/Pound

Multiply	By	To obtain
milliliter (mL)	0.03382	ounce, fluid (fl. oz.)
millimeter (mm)	0.03937	inch (in)
micrometer (µm)	0.03937×10^{-3}	inch (in)

GPS – global positioning system
BLM – U.S. Department of the Interior, Bureau of Land Management
USGS – U.S. Geological Survey

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By John Earle and LaDonna Choate

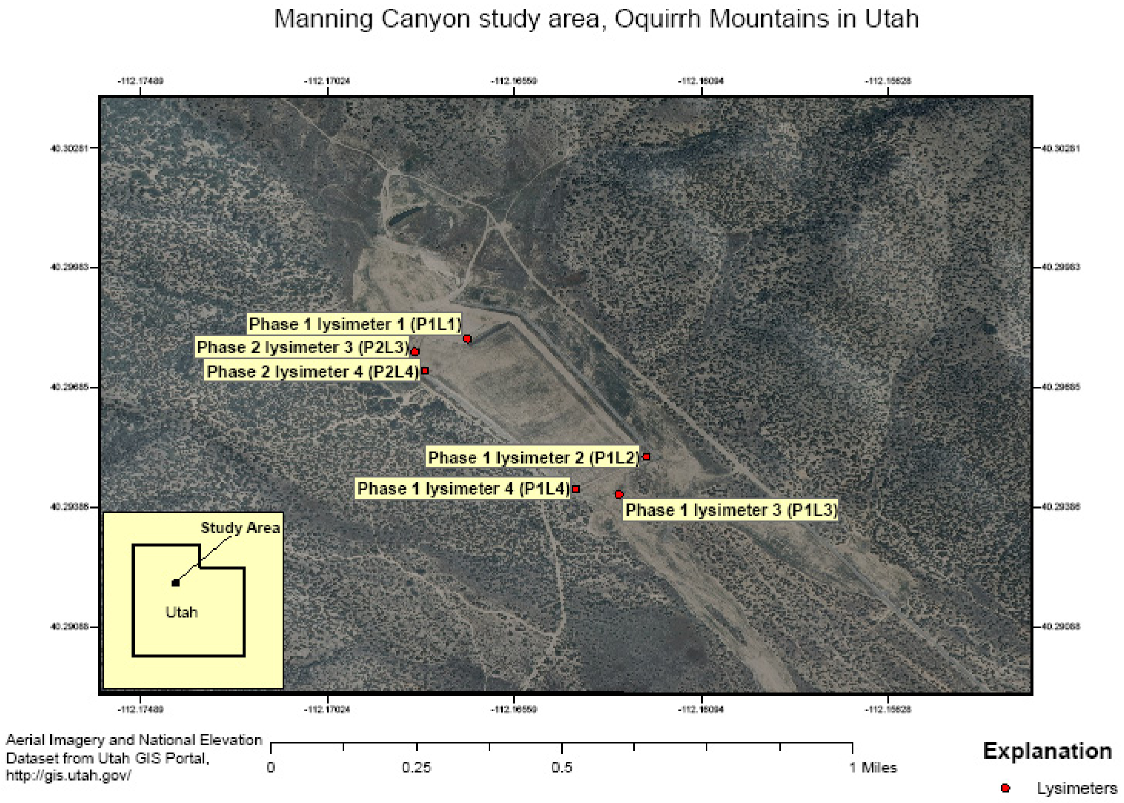
Abstract

This report presents chemical characteristics of transient unsaturated-zone water collected by lysimeter from the Manning Canyon repository site in Utah. Data collected by U.S. Geological Survey and U.S. Department of the Interior, Bureau of Land Management scientists under an intragovernmental order comprise the existing body of hydrochemical information on unsaturated-zone conditions at the site and represent the first effort to characterize the chemistry of the soil pore water surrounding the repository. Analyzed samples showed elevated levels of arsenic, barium, chromium, and strontium, which are typical of acidic mine drainage. The range of major-ion concentrations generally showed expected soil values. Although subsequent sampling is necessary to determine long-term effects of the repository, current results provide initial data concerning reactive processes of precipitation on the mine tailings and waste rock stored at the site and provide information on the effectiveness of reclamation operations at the Manning Canyon repository.

Introduction

This report describes water sampling and presents geochemical data from lysimeter sampling performed at the Manning Canyon repository near Fairfield, Utah, April 21 to April 23, 2008, as part of a U.S. Department of the Interior, Bureau of Land Management (BLM) mine-remediation project. The sampling and analysis were performed in cooperation with the BLM under an intragovernmental order (IGO NA1070023) between the U.S. Geological Survey (USGS) and the Bureau of Land Management. The Manning Canyon repository is located in the Mercur Mining District in the Oquirrh Mountains of Utah County, Utah, 40 miles south of Salt Lake City. Approximately 720,200 cubic yards of tailings and waste rock from gold- and silver-ore mining and processing have been deposited within the site (Ford and Ingwell, 2002). The Manning mill processed ore at the site from about 1890 to 1937.

The BLM developed design and installation requirements for the lysimeters to monitor repository performance at Manning Canyon and contracted installation of six nested lysimeters. A lysimeter is a device designed to collect pore water as it percolates downward through the soil or other material in which the lysimeter is installed. A lysimeter generally consists of a porous ceramic cup, a reservoir, and two nominal ¼-inch (approximately 6-mm) polyethylene lines that run from the reservoir to the surface. One line (typically black) is used as the vacuum and pressure line, and the second line (typically green) is the sample-collection line. The BLM design requirements for the lysimeter nests at the Manning Canyon repository specify three lysimeters within a single boring, capable of sampling from 5, 10, and 15 feet below land surface, respectively, thereby providing 18 distinct potential sampling points. The lysimeters were installed in two phases, designated as Phase I in 2002, and in 2003 as Phase II (fig. 1). Lysimeter installations from 2003 were designed for multiple-zone sampling. The tubing-bundle identifiers from 2002 installation as found at site P1L3, however, were not preserved sufficiently to indicate the sampling zone definitively, although a valid sample was collected from the lysimeter. (An asterisk has been placed next to that sample in the data table to indicate the sample-zone uncertainty. For this report, it is assumed that the sample collected was from zone 1 at the 5-foot depth.) The USGS and BLM scientists labeled and secured the P1L3 tubing and applied vacuum pressures to test tubing integrity and subsequently to collect water samples.



Aerial Imagery and National Elevation Dataset from Utah GIS Portal, http://gis.utah.gov/

Figure 1. Aerial view of Manning Canyon repository, Utah, showing location of lysimeters.

Sampling Procedure

Sampling efforts began with determination of the locations of the six nested lysimeters at the repository by using a hand-held global positioning system (GPS) receiver (table1). The crew opened the protective steel outer casings of the nested lysimeters and inspected the ¼-inch tubing lines to each lysimeter. Tubing lines were traced and marked, and clamps were installed. (All activities, including tubing and filter additions, line pressurization, sampling, and sample preservation, were performed while wearing nitrile gloves for personal safety and to eliminate sample contamination. The nitrile gloves were changed between samplings of lysimeters.) Any debris found on the tubing was removed carefully with a clean cloth. A new, dedicated piece of nominal 5/16-inch-diameter (approximately 8-mm) vinyl tubing was used to connect the black pressure/vacuum (P/V) tubing and the green sample tubing to the lysimeter pump and to a nominal 0.45-micrometer (approximately 0.00003937-inch) sampling filter. The vinyl tubing is flexible and stretches over the ¼-inch lysimeter tubing and the sampling filter.

Table 1. Lysimeter GPS locations at the Manning Canyon repository, Utah.

[Lysimeter locations were determined with a hand-held global positioning system (GPS) in decimal degrees as listed below to accuracy appropriate for the particular GPS receiver that was used]

Lysimeter nested location (zones at 5, 10, and 15 feet)	Latitude in decimal degrees	Longitude in decimal degrees
Phase 1 lysimeter 1 (P1L1)	40.2980556	112.1667500
Phase 1 lysimeter 2 (P1L2)	40.2951111	112.1623056
Phase 1 lysimeter 3 (P1L3)	40.2941667	112.1629722
Phase 1 lysimeter 4 (P1L4)	40.2943056	112.1640556
Phase 2 lysimeter 3 (P2L3)	40.2977222	112.1680556
Phase 2 lysimeter 4 (P2L4)	40.2972500	112.1678056

A hand-operated lysimeter pump equipped with a gage was used to create and indicate vacuum pressure or positive pressure on the lysimeter tubing. A clamp was used to close the lysimeter tubing to hold a vacuum within the lysimeter. Vacuum pressure was applied to the P/V tubing for a minimum of 20 minutes of pressure on the lysimeters; in most cases, however, vacuum pressure was applied, and sampling then occurred the following day. Field notes described the ability of the lysimeters to hold vacuum pressure. Acid-rinsed, high-density polyethylene (HDPE) bottles were used to collect the lysimeter water samples. Positive pressure was applied to the black P/V lysimeter tubing in order to push the sample out of the lysimeter collection bowl through the green lysimeter sampling tubing and filter, directly into the labeled nominal 125-milliliter (mL) sample bottle. Immediately after each sample was collected, 2 mL of 7.7 Normal nitric acid was added to preserve the sample, and the cap was tightened and taped. Each sample was placed in a separate plastic bag and placed into an ice-filled cooler. Field water-quality properties were not measured during this sampling due to small sample volumes and the need to filter and preserve samples quickly.

The samples remained in the custody of the sampling crew until the crew placed them in a refrigerator at the laboratory for analysis. Samples were labeled using the following convention: P1 or P2 for the construction phase, followed by L(1, 2, 3, or 4) for lysimeter number, and Z (05, 10, or 15) for zone depth. (Sample P2L1Z15 therefore indicates Phase II, lysimeter 1, zone 15.) Additionally, the sampling date and time were inscribed on the bottle, and all samples were filtered, acidified, and chilled. The sample-label information was recorded in the field notebook, which served as the chain-of-custody record for the samples. If a lysimeter lost vacuum pressure or did not produce a sample, approximately 100 mL of deionized water was added to the green lysimeter sample tubing, and another attempt was made to apply vacuum pressure to the lysimeter. Such efforts were recorded in the field notes (see Appendix).

Analysis

The samples were analyzed by the U.S. Geological Survey, Crustal Imaging and Characterization Team, Minerals Program Analytical Laboratory. All 17 acquired samples were analyzed for metals using inductively coupled plasma– mass spectrometry (ICP–MS). Sodium (Na) values typically are shown as not reported (nr) from the ICP–MS analyses (table 2) because those values were high and out of instrument range. All samples then were analyzed using inductively coupled plasma –atomic-emission spectrometry (ICP–AES) to quantify the sodium values. The ICP–AES sodium values subsequently were inserted into the ICP–MS data table. The ICP–AES and the ICP–MS procedures are chapters F and H, respectively, of USGS Open-File Report (OFR) 2002–0223 (link to Chapters F and H here) http://pubs.usgs.gov/of/2002/ofr-02-0223; fully detailed listings are given in the reference citations). The accuracy and precision of results, determined against reference standards for the analyses, are displayed below the analytical results in table 2. The results generally are within ±25 percent.

Table 2 lists available water-quality samples and chemical analytical results for water from lysimeters at the Manning Canyon repository. In general, the lysimeters located at the 15-foot zone did not produce a sample. In some cases, including the 15-foot zones, deionized water therefore was added in an effort to stimulate lysimeter production before resampling. In addition, the 5-foot zone of lysimeter P2L3 (P2L3Z05) and the 15-foot zone of P2L4 (P2L4Z15) did not seem to be functioning properly. Zone P2L3Z05 was not analyzed, resulting in a total of 17 samples.

Table 2. Chemical analyses of water samples from the Manning Canyon repository, Utah.

MANNING CANYON 2008 ANALYSIS.XLSX

MANNING CANYON 2008 ANALYSIS.PDF

Summary

The collected samples showed elevated levels of arsenic, barium, chromium, and strontium, which are typical of acidic mine drainage. The range of major-ion concentrations generally show expected soil values; the suite of analyses, however, missed some important anions, namely chloride, carbonate, and nitrate. Without those important analyses, charge balance cannot be calculated. Future sampling could validate existing data and supplement those data with a complete suite of major-ion chemistry in order to evaluate the representativeness of the collected lysimeter samples in regard to long-term repository performance. It is important to develop a sampling history, and additional samples could be collected from available lysimeters and wells in the nearby area to expand information on effectiveness of reclamation efforts at the Manning Canyon repository.

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Appendix

Field Notes from the Manning Canyon, Utah, Lysimeter Sampling

04/21/2008 Phase 2, Lysimeter 3 (P2L3) The crew applied 72 centibars (cbars) of vacuum pressure to the pressure/vacuum (P/V) tubing of Phase 2, Lysimeter 3, Zone 05, sample/field number P2L3Z05. The zone did not produce a sample when checked after 20 minutes. Vacuum pressure was applied to zones 15 and 10. After 30 minutes both zones produced a few drops of sample. Vacuum pressure was applied to all three zones and the pressure was maintained overnight.

P2L4 The crew applied 70 cbars of vacuum pressure to all zones. Zone 15 did not hold vacuum pressure.

04/22/2008 ***P2L4*** Zone 05 and Zone 10 held 60 cbars of vacuum pressure overnight. A 125-mL sample was collected, acidified, taped, and chilled both from Zone 05 and Zone 10. Zone 15 did not maintain vacuum pressure overnight. Approximately 125 mL of deionized water was added to the green sample tubing of zone 15.

P2L4Z15 will be monitored but did not seem to be functioning.

P1L1 The crew clearly marked the tubing bundles and applied 70 cbars of vacuum pressure to all of the zones at that lysimeter. Zone 05 later produced a 50-mL sample, and 70 cbars of vacuum pressure was reapplied. Zone 10 held approximately 10 cbars of vacuum pressure and produced 30 mL of sample. Vacuum pressure was reapplied to the zone. Zone 15 held approximately 5 cbars of vacuum pressure and produced approximately 10 mL of sample, an insufficient volume for analysis. Approximately 50 mL of deionized water was added to the zone, and vacuum pressure of 70 cbars was reapplied.

P1L2 The crew clearly marked all tubing and applied 70 cbars of vacuum pressure to all zones. Zone 05 held vacuum pressure and produced a 60-mL sample. Zones 10 and 15 did not hold vacuum pressure and produced no sample. Approximately 50 mL of deionized water each was added to Zones 10 and 15, and 70 cbars of vacuum pressure was applied to each zone.

P1L4 The crew found all tubing bundles marked and applied 70 cbars of vacuum pressure to all zones. Zone 05 held vacuum pressure and produced a sample. Zone 10 held 10 cbars of vacuum pressure but did not produce a sample. Zone 15 did not hold vacuum pressure and did not produce a sample.

P1L3 The crew found tubing bundles unmarked and made assumptions concerning zonal delineation based on the location of the tubing bundles in the protective outer casing. All zones were marked based on those assumptions, and vacuum pressure was applied to all zones. Zone 05 held vacuum pressure and produced a sample. Zone 10 held vacuum pressure and produced a 50-mL sample. Zone 15 held vacuum pressure but did not produce a sample. Approximately 100 mL of deionized water was added to zone 15, and vacuum pressure of 70 cbars was applied to the zone.

04/23/2008 ***P2L4Z15*** Deionized water was added to that zone on April 22, 2008, in an attempt to stimulate the lysimeter. Zone 15 did not hold vacuum pressure overnight, but a sample was collected. A hissing noise was observed downhole from that zone after the sample was collected, which would indicate a tubing disconnection or leak.

P2L3 Zone 10 held vacuum pressure overnight and a sample was collected. Zone 15 also held vacuum pressure overnight and a sample was collected. Zone 5 did not hold vacuum pressure overnight. Therefore, 70 cbars of vacuum pressure were applied to the zone.

P1L4 Zone 10 held vacuum pressure overnight and a sample was collected. Zone 15 held vacuum pressure overnight and a sample was collected. Deionized water was added April 22, 2008, to that zone.

P1L3 Zone 15 held vacuum pressure and a sample was collected. Deionized water was added to that zone on April 22, 2008. Zone 10 held vacuum pressure and a sample was collected. Deionized water was added to the zone on April 22, 2008. Zone 05 held vacuum pressure and a sample was collected as an additional sample. No deionized water had been added to that zone.

P1L2 Zone 10 and Zone15 held vacuum pressure but produced no sample. Zone 05 was sampled on April 22, 2008.

P1L1 Zone 15 held vacuum pressure and a sample was collected. Deionized water was added to that zone on April 22, 2008. Zone 10 held approximately 20 cbars of vacuum pressure overnight but produced no sample.

P2L3 Zone 05 did not hold vacuum pressure overnight. That zone must have a tubing malfunction.