

DALE, Michael¹, LONGMIRE, Patrick², GRANZOW, Kim², YANICAK, Stephen², and MAYER, Richard³, (1)New Mexico Environment Department, 2905 Rodeo Park Drive East, Bldg 1, Santa Fe, NM 87505-6303, (2)New Mexico Environment Department, DOE Oversight Bureau, 1183 Diamond Drive, Suite B, Los Alamos, NM 87544, (3)US EPA, Federal Facilities Section (6PD-F), 1445 Ross Avenue, Dallas, TX 75202

Abstract

The New Mexico Environment Department (NMED) initiated a geochemical investigation in 2011 to determine low-level background concentrations of 23 EPA Target Analyte List metals (excluding Hg) and 19 other trace metals naturally present in the regional aquifer at Los Alamos, New Mexico. The purpose of the project is to update and supplement background chemical data for the regional aquifer collected by Los Alamos National Laboratory (LANL) and increase the groundwater resources beneath and downgradient from the facility. High resolution-inductively coupled plasma mass spectrometry (HR-ICPMS) is used to quantify background solute concentrations at low levels of detection and quantitation. Instrument detection and reporting limits for the various dissolved trace elements are below 0.001 mg/L. The NMED collected 102 filtered groundwater samples for HR-ICPMS analyses at 34 well screens located on the Pajarito Plateau and eight springs discharging in White Rock Canyon southeast of Los Alamos, New Mexico. The sampling stations represent each of the five major Pliocene and Miocene age regional-aquifer lithologies, including the Puye Formation, Tschicoma Formation, Totavi Lentil, basaltic rocks of the Cerros del Rio volcanic field, and Chamita Formation. Statistical analyses for each background solute, including calculating upper tolerance limits (UTL), were conducted using the US EPA software package ProUCL, Version 4.1. For each constituent, the selected 95% UTL was based on 95% coverage. Solute concentrations above instrument detection limits and below reporting limits (J values) were considered in calculating UTL values. Updated UTL values for dissolved Cr, Ba, Fe, and Mn are lower than UTL values provided by LANL in 2011. UTL values calculated by both the NMED and LANL are very similar for B, Ca, Mg, silica, Na, U, and V. An updated UTL for dissolved Sb was slightly higher than the UTL value provided by LANL. Differences in UTL values are most likely related to a higher percentage of detectable results and associated lower detection and guantitation limits for the analytes, as well as the quality and increased number of background sampling locations.



Regional setting of Los Alamos National Laboratory

For additional information please contact Michael Dale at michael.dale@state.nm.us or (505) 661-2673

DATA SOURCES: (1) New Mexico Environment Department

- (2) LANL Earth and Environmental Sciences Geology and Geochemistry Research Lab (EES-14 GGRL)
- (3) Intellus New Mexico Database: http://www.intellusnmdata.com/

Objectives and Analytical Methods

The purpose of the investigation is to provide chemical data that will enhance groundwater protection at Los Alamos, New Mexico. The regional aquifer, a sole-source water supply, is positioned approximately 300 meters beneath Los Alamos National Laboratory (LANL), New Mexico. The regional aquifer is vulnerable to contamination from historical (since the mid-1940s) liquid-waste discharges from LANL. Determining background concentrations of naturally occurring trace elements and metals such as chromium and uranium are vital to early-warning contaminant detection; delineating nature and extent of contamination; assessing the reliability of monitoring wells; quantifying natural attenuation; and assessing remedial actions such as pump and treat systems.

The investigations performed include a variety of analytical methods:

Dissolved metals - A total of 41 dissolved metals, including 22 of the 23 Target Analyte List metals, were analyzed using high resolution-inductively coupled plasma mass spectrometry (HR-ICPMS or HRMS) for analytes with concentrations typically less than 10 μ g/L (modified EPA Method 200.8) and inductively coupled plasma optical emission spectroscopy (HR-ICPOES) for analytes typically greater than 10 μ g/L (EPA Method 6010B).

Anions, Hardness, and TDS – Analytical results for dissolved anions, hardness, and total dissolved solids (TDS) were provided by LANL as part of their ongoing site-wide groundwater monitoring program. LANL applied EPA Method 300.0 for analyses of bromide, chloride, fluoride, and sulfate; EPA Method 310.1 for total carbonate alkalinity; EPA Method 350.1 for NH₃ as N; EPA Method 353.2 for nitrate and nitrite as nitrogen; and method SW-846-6850 for perchlorate Hardness and TDS were determined by methods SM:A2340B and EPA 160.1, respectively.



Sampling locations for regional aquifer background study

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Mean dissolved

aquifer -----





Solute Isopleth Maps and Solute Concentrations in Hydrostratigraphic Units

n = 40

Miocene pumiceou

oumiceous

deposits

n = 34







Geology at the water table and water-table elevation contours

From "The 2009 three-dimensional, geologic models of the Los Alamos National Laboratory site, southern Española basin, and Española basin", Cole and others, 2010, LA-UR-09-03701

Water contours from LANL, 2009 and INTERA, 2006.

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Previous Work and NMED Recent Results

The requirement and guidance for determining background concentrations of naturally occurring constituents in groundwater beneath a Federal regulated facility are provided by the Environmental Protection Agency (EPA): 40 CFR Part 265 Subpart F and EPA's March 2009 "Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance". The State of New Mexico's Compliance Order on Consent, dated March 1, 2005, requires LANL to submit a groundwater background report for naturally occurring metals and other chemical constituents. Since 2005, LANL has produced several groundwater background investigation reports with revisions and updates. LANL's most recent background report was submitted and approved by NMED in 2011. One significant issue with LANL's background data set is the high frequency of non-detections for dissolved metals such as arsenic and chromium at concentrations ranging from 5 to 10 µg/L in the regional aquifer. As a result of including a large population of nondetected data, the facility's calculated upper tolerance limits for many constituents are not precise or representative of solute concentrations in the regional aquifer. The NMED initiated an investigation to produce a technically defensible data set that is more representative of background concentrations of dissolved metals. Analytical results presented in this poster provide a greater confidence in determining presence or absence of low-level contamination by dissolved metals in the regional aquifer.

Frace Metal (Dissolved)	NMED, 2013 % Non-Detected	Det. Limit (µg/L)	LANL, 2011 % Non-Detected	Det. Limit (µg/L)	Standard ¹ or MCL (µg/L)	NMED, 2013 *Upper Tolerance Limit (μg/L)	LANL, 2011 *Upper Tolerance Limit (μg/L)
Antimony	0	0.005	99	0.5	6	2.72	0.61
Arsenic	0	0.02	38	1.5 to 6	10	2.31	3.90
Chromium	0	0.05	15	1 to 2.5	50 ¹ & 100	5.53	10.44
Lead	40	0.005	98	0.5	15	0.06	0.31
Manganese	1	0.005	53	1 to 2	200 ¹	11.77	21.21
Nickel	13	0.05	34	0.5 - 2.5	200 ¹	2.28	2.50
Selenium	0	0.04	97	1 to 6	50 ¹	0.66	1.84
Thallium	29	0.001	83	0.3 to 0.4	2	0.02	0.77
Uranium	0	0.001	5	0.05	30	1.27	1.54

Quartile Lower 25% Quartile on Miocene



Quartile Lower 25% deposit umiceous

Summary and Conclusions

- Data obtained by HR-IPCMS and HR-ICPOES indicate that concentrations of certain trace elements such as aluminum, antimony, boron, chromium, strontium, and uranium tend to be associated with specific lithologic units at Los Alamos, NM.
- The data set derived from this investigation is essential in determining the geochemical evolution processes (adsorption and mineral precipitation) occurring in groundwater along regional-aquifer flow paths from areas of recharge to points of discharge such as production wells or springs. The HR-IPCMS and HR-ICPOES analytical methods and resulting data could potentially be used to "fingerprint" the groundwater with respect to water-rock reactions along regional flow paths, much like stable isotopes (e.g., ^{87/86}Sr) are used.
- Utilizing HR-ICPMS and HR-ICPOES analytical methods, versus standard-resolution methods such as SW-846:6020, for quantifying concentrations of trace elements in groundwater significantly improve the quality of the data set, especially when determining background. The data set provided by this investigation increased the level of confidence in detecting potential trace contaminants at water-supply and monitoring wells located near and downgradient of known contaminant plumes. These data are also used for determining the nature and extent of contamination, the reliability and representativeness of groundwater samples collected at monitoring wells and springs, and assess the extent of natural attenuation and progress of active aquifer remediation.



